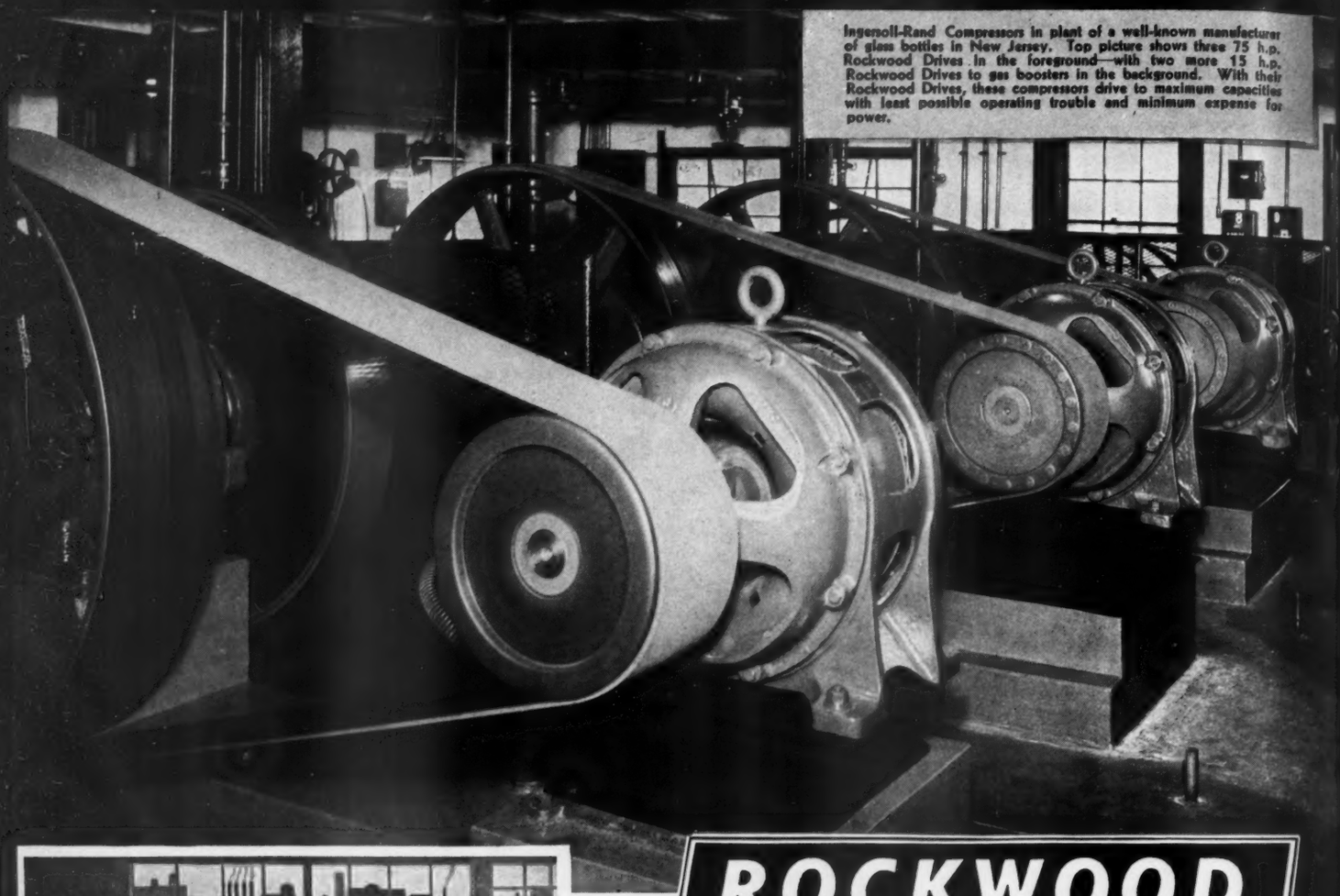
Compressed Air Magazine

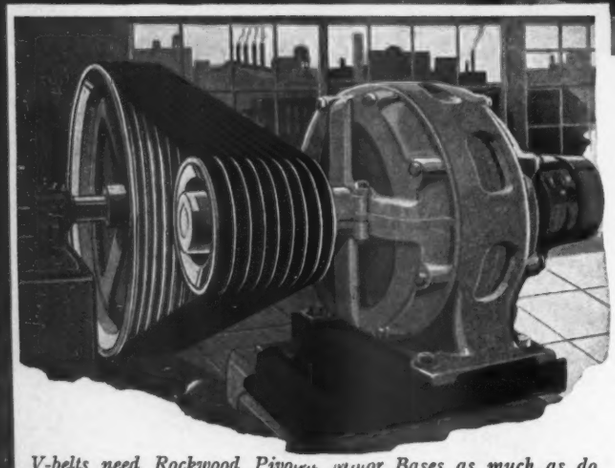
VOLUME 47 · NUMBER 6 JUNE 1942 LONDON · NEW YORK · PARIS

GOLD-DREDGE BUCKETS

MORE DEPENDABLE SERVICE FROM YOUR COMPRESSORS



Ingersoll-Rand Compressors in plant of a well-known manufacturer of glass bottles in New Jersey. Top picture shows three 75 h.p. Rockwood Drives in the foreground—with two more 15 h.p. Rockwood Drives to gas boosters in the background. With their Rockwood Drives, these compressors drive to maximum capacities with least possible operating trouble and minimum expense for power.



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ROCKWOOD PIVOTED MOTOR BASES

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ON THE COVER

OUR cover picture shows the lower tumbler and buckets of a 10-cubic-foot gold dredge, which is one of eight being operated near Fairbanks, Alaska, by the United States Smelting & Refining Company. Compressed-air tools were extensively used in the construction of the dredges and now save much time in maintenance and repair work. Digging lips on old-style buckets are renewed by riveting, and on the new type, where they are held in place by lug bolts, the retaining nuts are quickly run off and on with pneumatic wrenches. Similar wrenches are employed for putting in new trommel-screen plates, while chipping hammers, drills, and other air-driven tools perform many other necessary tasks. On the newest dredge compressed air operates the friction clutches. During subzero weather the air lines are protected from freezing by the use of Tanner gas. The photograph won first award in our recent cover-picture contest. It was submitted by W. C. Royce of Fairbanks.

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IN THIS ISSUE

AN UNUSUAL use for Calyx core drills is described in our leading article, which deals with the repair of leaky foundation rock at Hales Bar Dam in Tennessee. Somewhat similar operations were carried out a few years ago at the Burrinjuck Dam in New South Wales. The amount of core drilling that will be done at Hales Bar Dam before the project is completed, will, it is believed, be greater than any heretofore concentrated at one location.

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GRAPHITE or plumbago is the most important mineral product of Ceylon. After more than 100 years of hand mining, a few of the larger properties are being mechanized. As a result, output is going up and costs are coming down. An article by John N. Peterson gives the details.

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NOT many years ago most dirt was moved in scrapers drawn by horses. The same principle, now mechanized, is being widely used in moving and loading ore, coal, and waste in mines. A 5-page article describes this scraper mucking and cites its advantages.

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AMONG the unheralded pioneers are those men that go to out-of-the-way places to erect machinery. Few of their experiences ever get into print. Our article on Montana chromium tells how difficulties were overcome in getting portable compressors into two remote mountain sections before adequate roads were available.

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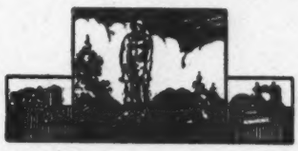

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Stopping Leakage Under Hales Bar Dam

C. H. Vivian

THE Tennessee Valley Authority is using a novel method for placing a vertical curtain of concrete in the foundation rock just upstream from Hales Bar Dam to stop water from flowing underneath the structure. The cut-off wall is being formed of a series of overlapping concrete columns, each of which is poured in an 18-inch circular hole made by a core drill. There will be three such wall sections, and their aggregate length will be approximately 625 feet, or more than half the length of the 1,200-foot spillway. Intervening and flanking areas of the foundation rock will be made watertight by grouting. Construction of the wall will entail the drilling of up to 40,000 linear feet of 18-inch hole and the removal of more than 2,500 cubic yards of material. The work is being done while the water back of the dam is at normal reservoir level and without interfering with the operation of a hydroelectric plant at one end of the dam and a navigation lock at the other.

Hales Bar Dam is on the Tennessee River 33 river-miles downstream from Chattanooga, Tenn., and was purchased by the TVA in 1939 from the Tennessee Electric Power Company. It has an overall length of 2,315 feet of which 1,200 feet is concrete spillway, 371 feet is concrete powerhouse and lock, and 744 feet is earth embankment. Its maximum height is 83 feet above the lowest foundation rock. The navigation lock measures 60x267 feet and has a lift of 37 feet.

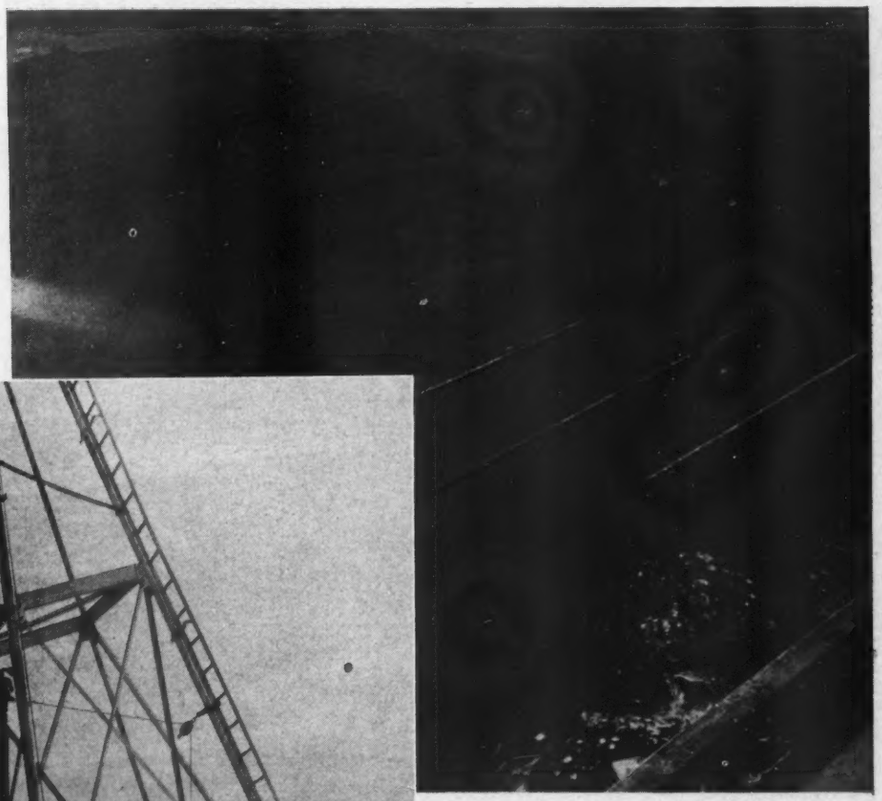
The dam was the first one built on the Tennessee River and is one of the earliest large gravity-type concrete dams erected anywhere. Because of this, and the fact that its construction was attended by a succession of delays and difficulties attributable to poor foundation rock, it occasioned widespread interest among engineers. In this respect its history somewhat parallels that of the Austin Dam in Texas, which antedated it by fifteen years. Hales Bar Dam was projected by the Chattanooga & Tennessee River Power Company to supply power for Chattanooga. The site was selected and acquired in 1904, and construction was started in October, 1905, under a $3,000,000 contract which included the dam, powerhouse structure, and a transmission line to Chattanooga.

At that time the present technique of dealing with faulty foundation rock had not been developed, and when the contractor ran into trouble he did not know how to cope with it effectually. Conditions were satisfactory in the lock area, but badly broken and seamy rock was found under much of the power-plant and spillway sections, and so much water came into the cofferdams from underneath that the pumps could not handle it. Grouting sealed off the flow in some areas, but failed to do so in others, and it became necessary to sink 26 pneumatic caissons ranging up to 54x72 feet in size to overcome the water. Three successive contractors went bankrupt on the work, and it was finally concluded by an engineering firm for the owner's account. More than eight years was required to complete the job.

Supplementary grouting was believed to have sealed all the water channels, and it possibly did. But, if so, new ones were subsequently opened by the differential head, and it was not long after the struc-

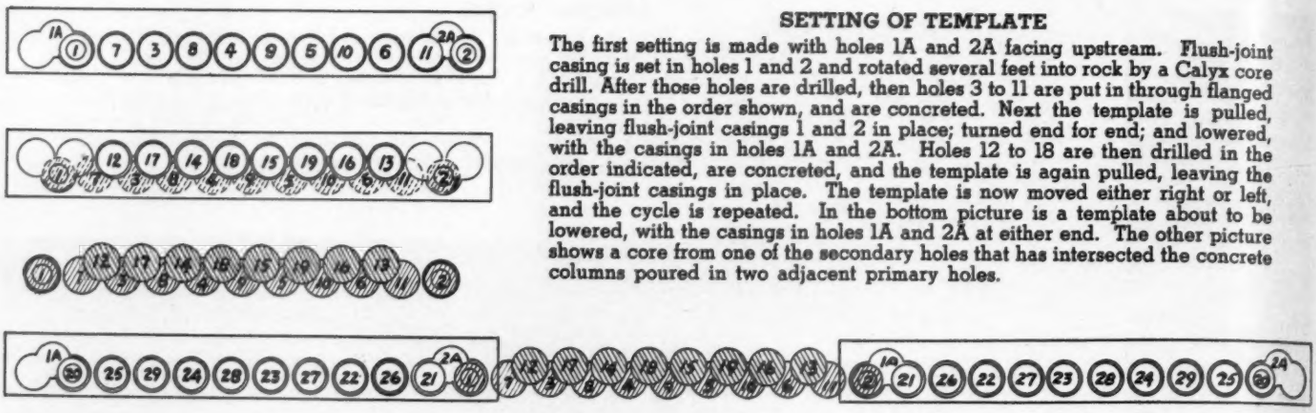
GENERAL VIEWS

The picture at the extreme left was taken from the roof of the powerhouse and shows the line of Calyx core drills at work on the trestle with the platform of barges alongside and the floating crane nearby. In the foreground is one of the 60-foot flanged casings through which the tools operate. In the center is a view along the downstream face of the dam showing how the working trestle is supported on it. One of the boils downstream of the dam caused by water flowing under the structure is seen just below. When colored dye is introduced in a diamond-drill hole penetrating a creviced area above the dam, it shows up downstream in a matter of seconds. At the bottom is pictured a 20-foot assembly of 18-inch core-drilling tools.



tune went into service before considerable water was flowing under it. At this particular point the river flows south, and the dam rests upon limestone strata that dip at an angle of 8° toward the east. Interbedded with the limestone are thin layers of shale, and the washing out of these causes horizontal openings. Streaks of calcite run irregularly across the limestone beds, and their solution creates vertical openings. These sources of leakage are supplemented to some extent by breaks in the formation attributable to faulting. The horizontal passages are, apparently, largely in the upper 30 feet of the foundation structure and can be taken care of effectually when they are located. Faulting probably accounts for relatively little leakage. Solution of the calcites leaves irregular passages that are difficult to trace and consequently troublesome to deal with. It is believed that they permit the escape of large quantities of water.

As soon as the leakage revealed itself in the form of boils on the downstream side of the dam, the original owners recognized the importance of stopping it both to prevent the waste of water and to protect the dam against possible cracking and subsidence resulting from the undermining of its foundation. All attempts to plug the openings were unsuccessful, and ranged from the practical to the bizarre. Initially, rock was dumped into channel intakes upstream of the dam and then blanketed with clay, but the water soon opened new passages. Thereafter, concrete in bags and various other materials such as cotton, mattresses, and bedsprings were tried. It is reported, although not substantiated, that a carload of women's old-fashioned stay-type corsets was even included in the assortment. The net result of all these efforts was complete failure.



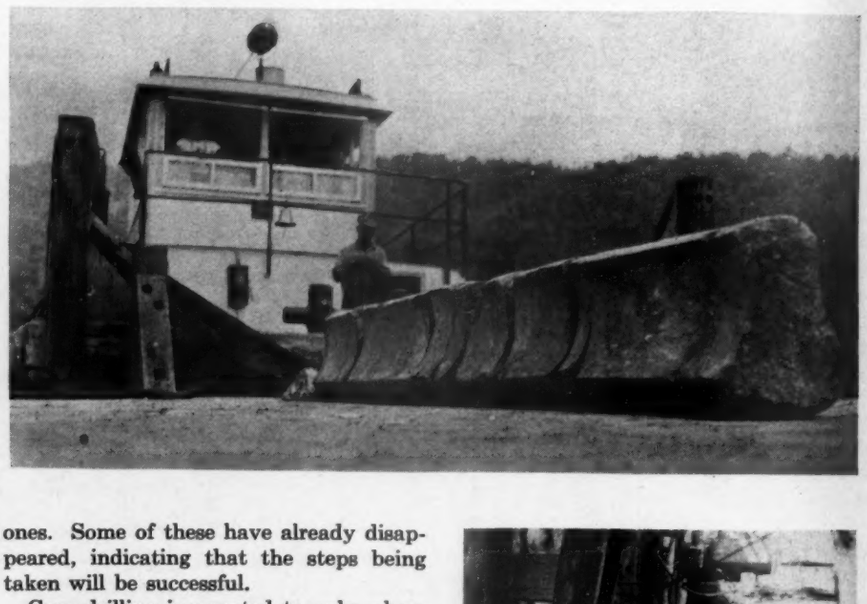
SETTING OF TEMPLATE

The first setting is made with holes 1A and 2A facing upstream. Flush-joint casing is set in holes 1 and 2 and rotated several feet into rock by a Calyx core drill. After those holes are drilled, then holes 3 to 11 are put in through flanged casings in the order shown, and are concreted. Next the template is pulled, leaving flush-joint casings 1 and 2 in place; turned end for end; and lowered, with the casings in holes 1A and 2A. Holes 12 to 18 are then drilled in the order indicated, are concreted, and the template is again pulled, leaving the flush-joint casings in place. The template is now moved either right or left, and the cycle is repeated. In the bottom picture is a template about to be lowered, with the casings in holes 1A and 2A at either end. The other picture shows a core from one of the secondary holes that has intersected the concrete columns poured in two adjacent primary holes.

In 1925, George W. Christians of Chattanooga proposed and carried out another scheme that met with some success. From an inspection gallery running longitudinally through the dam he drilled holes pointing slightly upstream and downward into the foundation rock. Into them was forced asphalt which was kept fluid by heat from electric wiring. That the grouting penetrated many of the crevices has been proved by the coring now in progress. It reduced the leakage temporarily, but new channels gradually developed.

As soon as the TVA took possession of the dam, its engineering department began the study of the fascinating problem of thwarting the water flow. Numerous possible solutions were proposed and studied, and it was concluded that the only practical measure was to place a watertight, pressure-resistant wall across the streambed just above the dam and to extend it far enough down into the foundation to reach sound rock. Various methods of doing this were considered, and the one now being carried out was decided upon. The necessity of maintaining the reservoir at operating level for power generation and navigation purposes precluded draining it either for inspection or for the proposed work. The affected areas might have been exposed by constructing cofferdams, but these would have had to be very large and it was certain that difficulty would have been experienced in keeping them unwatered. Some other way of putting in the wall therefore had to be devised.

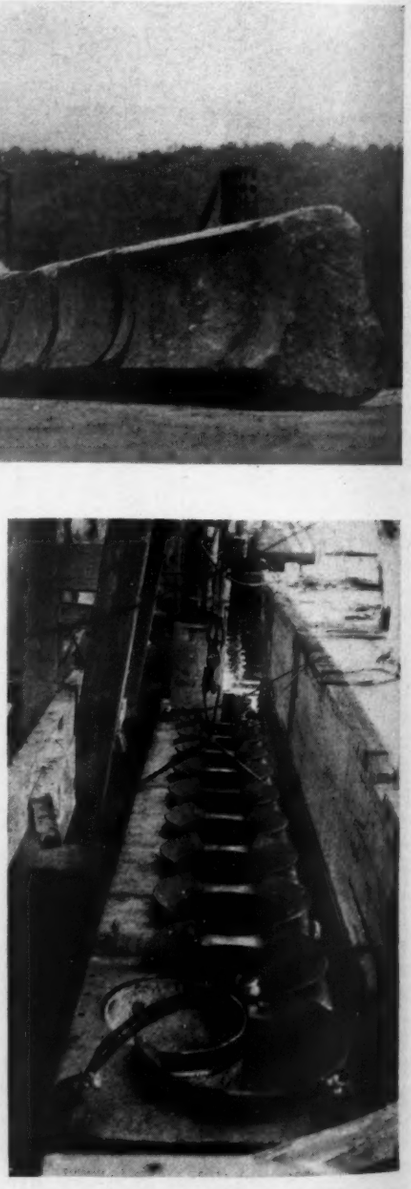
Adjacent to the dam the water is approximately 45½ feet deep and about 10 feet of overburden covers the foundation rock. The lowest-known cavities discovered by exploratory drilling were 92 feet beneath the rock surface. Consequently, it was necessary to find means and methods suitable for excavating and for placing concrete to a depth of at least 147½ feet beneath the water level. Core drilling seemed to be the answer, and the results so far obtained fully corroborate the correctness of the procedure. At the outset of the present work it was estimated that 1,700 second-feet of water was passing under the dam. This evidenced itself downstream of the structure in the form of five major boils and several smaller



ones. Some of these have already disappeared, indicating that the steps being taken will be successful.

Core drilling is resorted to only where the rock is broken up so badly that it cannot be consolidated by conventional grouting. The first step is to put down a line of diamond-drill holes on 20-foot centers to ascertain the underground conditions. The holes are 3 inches in diameter, and the cores taken from them are 2⅛ inches in diameter. Where the rock thus exposed proves to be fairly sound, cement grout, occasionally containing some calcium chloride to accelerate setting, is pumped into each hole at several levels. Additional holes are then drilled midway between the first ones and similarly grouted, and these are followed by more holes to reduce the spacing as required until consolidation is believed to be adequate.

The pressures used for grouting range from 30 pounds per square inch near the rock surface to 70 pounds at depths of 100 feet. The policy is to apply fairly low pressures and to drill extra holes wherever necessary. Grout consumption varies greatly, but averages about three bags of cement per foot of hole. The ratio of water to cement is ½ to 1. In some areas the deeper layers of rock are found to be sufficiently tight to hold grout, while the upper ones are so fragmented as to require further treatment. In such cases the con-



crete-cylinder cut-off wall is extended down only far enough to reach the zone previously grouted.

The cut-off wall consists of a double row of concrete cylinders, as an accompanying drawing shows. There will be

three such wall sections, as has already been mentioned, and in each one the holes in the line nearest the dam are drilled first and filled with concrete. Then those in the second line are drilled and poured. The latter are 8¾ inches upstream from the first holes and staggered with them as regards centers, thus overlapping the cylinders already in place 3 inches provided all holes are kept exactly vertical. This means that each hole in the second row cuts into two of the cylinders in the first row, removing an elliptical section from each of them. If the work is accurately done, the result is an integral wall made up of the intersecting columns. With the equipment available, holes can be kept close enough in line in most cases to establish contact between the two rows of cylinders. Where there are gaps, they can be made watertight by grouting.

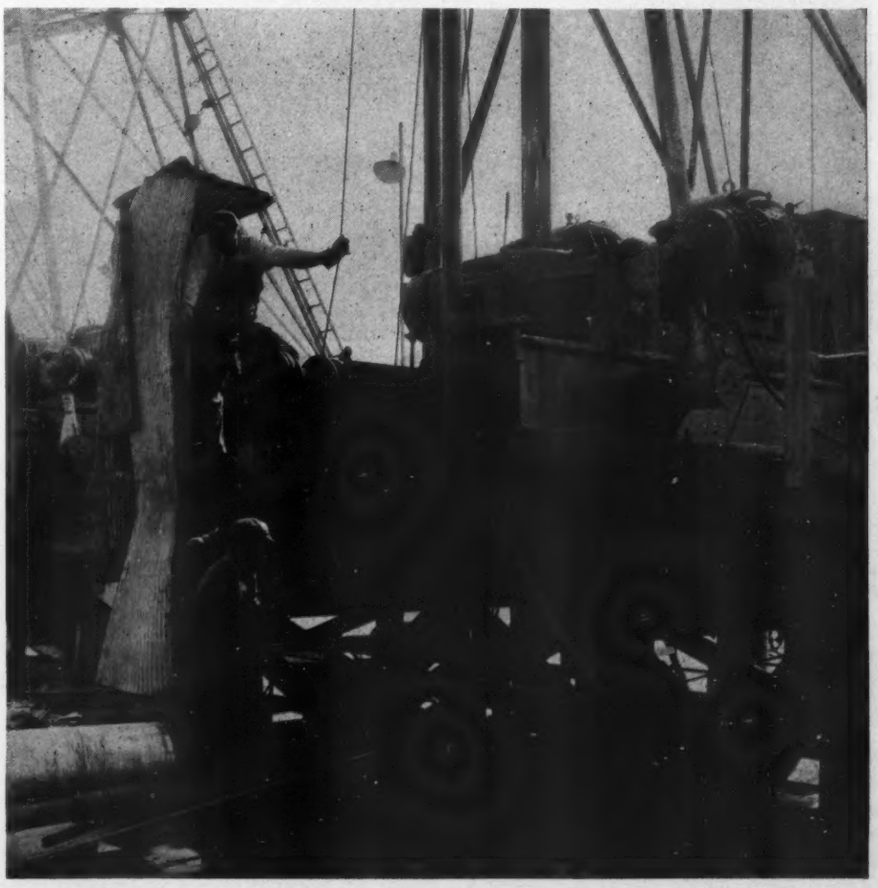
There was no precedent for an operation of this kind, and the details of the procedure had to be worked out and equipment adapted accordingly. All drilling is carried on from the top of a wooden trestle erected on top of the dam and having its deck 11 feet above the flashboard level of the water. A continuous line of barges beneath the trestle and just upstream from the dam provides a working platform and room for laying out tools and materials. The drill rigs are served by a floating whirler crane which is moved about by a tugboat. The latter also tows the barges that deliver materials, as well as a concreting barge with a mixer and a supply of cement and aggregates on board.

It was desirable to drill the holes of the cut-off wall as large as possible so as to keep down the number required. However, the underwater nature of the work precluded lowering a man into each hole to assist in breaking off the core, as has been the practice on TVA foundation-inspection work for which 36-inch Calyx drills have been used since the dam-building program started. Consequently, the size of the core was limited to one that could be detached by wedging it into the core barrel with pea gravel. Actually, cores up to 12 feet in length have been regularly removed in this way. Consideration also had to be given to the drilling difficulties presented by the service conditions. Mere depth is no great obstacle, since holes several hundred feet deep can be readily drilled with equipment of this type. But in this case it was known that cavities would be encountered where only a part of the bit would be rotating on rock, and that water velocities as high as 4½ feet per second would exert great pressure on the tools and tend to bind them in the hole.

Because of these various factors, it was decided that an 18-inch hole could be most satisfactorily cored. Since the inception of its dam-building program the TVA has utilized Ingersoll-Rand Calyx core drills in connection with foundation-exploration and grouting work, and preliminary experimental drilling was done at Hales Bar with two rigs that were already on hand. These were gasoline-engine-driven machines designed for use with 36-inch tools and were adapted for the service to gain advantage of the considerable power that they offered. The tests showed that an even heavier and sturdier unit was desirable, with the result that drills for handling 48-inch tools under normal conditions were specified for the job. Nine of these machines have been furnished the TVA by Ingersoll-Rand Company. They are made of standard parts, but include some special features to fit them for the Hales Bar work. Because of difficulties experienced in obtaining materials, manufacturing was delayed, and the drills have been delivered one or two at a time since operations were started last October. Meanwhile, the two 36-inch rigs continue in service to expedite progress pending arrival of the larger equipment.

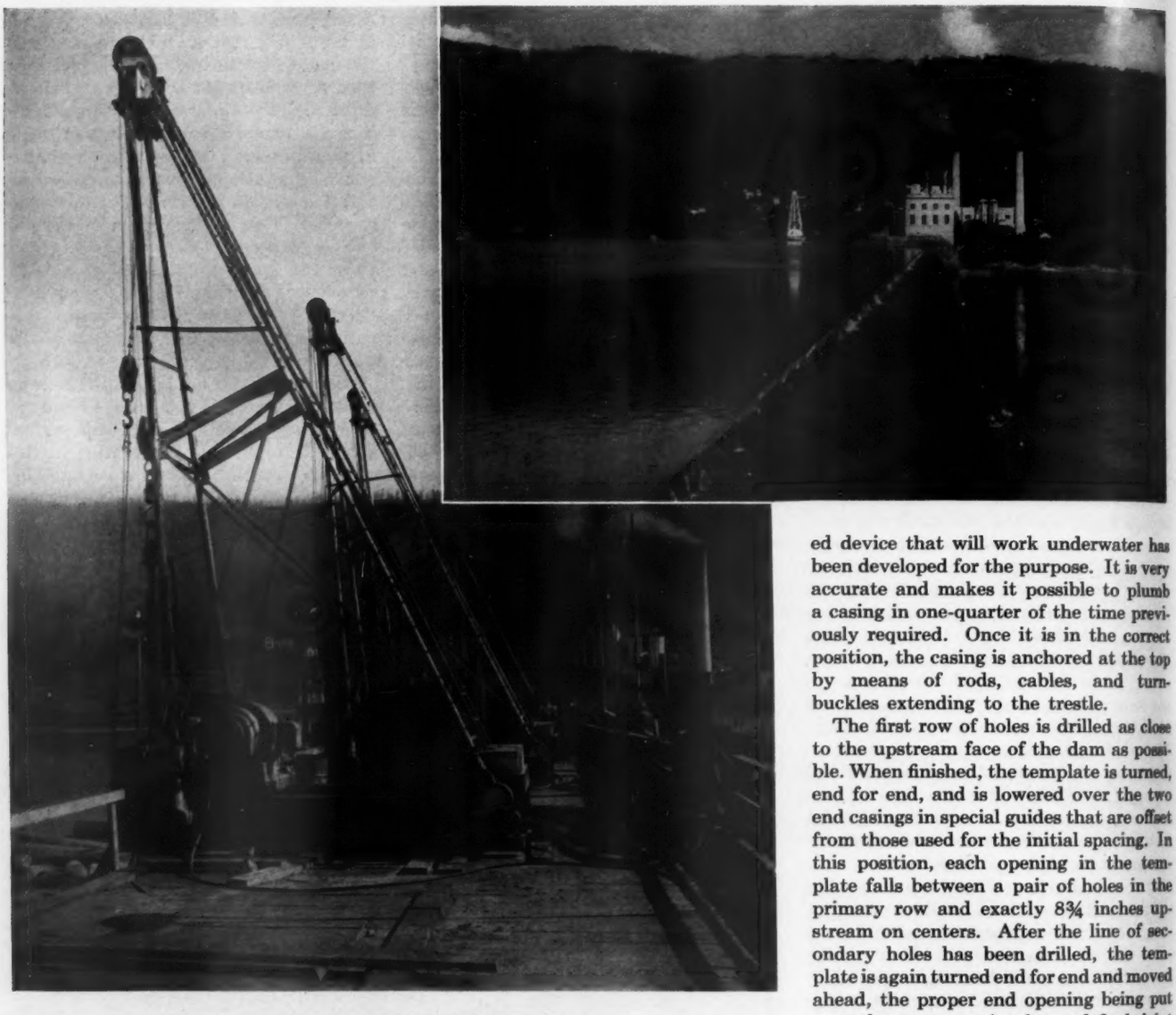
The holes are drilled through 20-inch steel pipe ½ inch thick and made up in 60-foot lengths so as to extend through the water and into the foundation rock. The casing is rotated so as to seat it 2 or 3 feet in the rock. The experience gained with the first drills that were used made it plain that several speeds should be available at all times in order to insure maximum progress regardless of the type of drilling encountered. Multiple-speed control and constant horsepower were essential, and 4-speed, 40-hp. driving motors were specified. They rotate the tools at 50, 75, 100, or 150 rpm., and the operator can vary the speed by means of selector switches. For lifting the tools there is an electric hoist with a 3,500-pound rope pull on one side of the derrick base and an air hoist of 2,000-pound rope pull on the opposite side. The latter offers extra pulling power when it is required and can be utilized by itself when electric current is off. In order that the floating derrick can work over the drill hole when handling casing, the drill derrick is designed so that it can be moved back out of the way.

When a series of holes is started, a structural-steel template with twelve openings on 24-inch centers is lowered into the water to within about 6 feet of the rock surface from which the overburden has previ-



BREAKING DRILL-ROD JOINTS

The pounding action of the drill bit in cavities tightens the threaded joints of the 4½-inch oil-well-type drill rods to such an extent that the most powerful chain wrenches obtainable are required to loosen them. Those used on the 48-inch drill rigs are rated at 150,000 foot-pounds torque. A 3-part wire cable is reeved through snatch blocks and attached to the end of the breakaway wrench. Pull is then exerted on the line by an air-hoist while the adjacent drill-rod section is held stationary by the holdback wrench.



TRANQUILLITY AND INDUSTRY

The upper picture shows Hales Bar Dam before the current operations were started. It was taken from near the lock end, looking westward toward the hydro-electric and steam generating plants. Below are seen some of the Calyx core drills now at work on the trestle erected on top of the dam. Each machine is driven by a 40-hp., 4-speed motor through a double roller chain extending to a heavy-duty, trunnion-type drill head. The working parts are mounted on sliding sole plates to permit moving them back when the floating crane that services the operations is to be swung over the drill hole. The tubular-steel derrick is 30 feet high and has retractable rear legs so that the crown block can be moved out of the way of the crane boom. Although special features have been embodied in these drills to adapt them for operating the 18-inch tools required, they can be transformed into regular 48-inch coring units suitable for putting down holes for the inspection of subsurface geological conditions in dam-foundation areas. Drills of this type have been used in several western metal mines to bore ventilating shafts and pilot openings to be enlarged into shafts.

ously been dredged with a clamshell bucket. The template is plumbed, and then a length of 20-inch casing is set in one of the end holes by the crane. The core drill, acting through an adapter connection between a flange on the casing and the drill tools, rotates the casing until it is 2 or 3 feet in the rock. A second casing is next inserted in the hole at the opposite end of the template and is similarly seated. These casings are made with flush joints, inside and out, and are held in vertical position by rods and turnbuckles attached to their tops and to the trestle. Holes are then drilled through the end casings, which are left in place to hold the template until the intervening holes are completed. The latter are drilled through flanged casings set in the respective openings. Each casing is rotated into the rock for about 6 inches to hold it, after which it is plumbed. Until recently, this was done with a plumb bob which could not be lowered until the casing had been pumped out—an operation that was sometimes difficult and time-consuming. Lately an electrically operated device that will work underwater has been developed for the purpose. It is very accurate and makes it possible to plumb a casing in one-quarter of the time previously required. Once it is in the correct position, the casing is anchored at the top by means of rods, cables, and turnbuckles extending to the trestle.

The first row of holes is drilled as close to the upstream face of the dam as possible. When finished, the template is turned, end for end, and is lowered over the two end casings in special guides that are offset from those used for the initial spacing. In this position, each opening in the template falls between a pair of holes in the primary row and exactly 8¾ inches upstream on centers. After the line of secondary holes has been drilled, the template is again turned end for end and moved ahead, the proper end opening being put over the near, previously used flush-joint pipe to start a new series of primary holes.

The drill-tool assembly is approximately 20 feet long. It is made up of a calyx at the top to catch the sludge brought up by circulating water, of a core barrel 14 feet long, and of a cutting bit at the bottom. The calyx and core barrel are standard 18-inch pipe with ½-inch wall. The bit is a cylinder of steel having a wall thickness of 1⅛ inches. Observation has shown that the zone of greatest wear is just above the bit, so a renewable female-coupling section 18 inches long is inserted at that point.

During the drilling of the first 20 feet of a hole, a circular steel strip 2 inches wide and ¼ inch thick is welded around the core barrel. This reduces the clearance between the outside of the barrel and the inside of the casing and keeps the tools in vertical alignment. During this period it is the practice to plumb the drill spindle after each section of core is removed. After 20 feet of depth has been attained, the long bearing surface of the tools in the hole maintains the alignment. If the hole is started plumb, it will remain

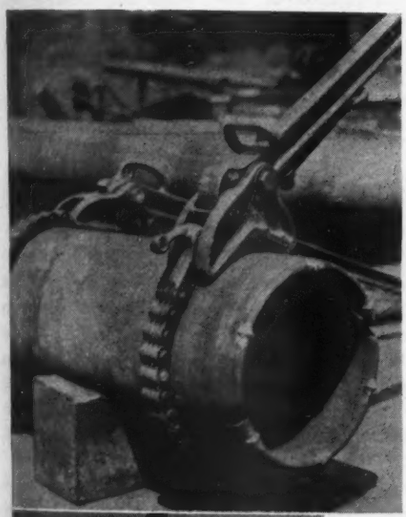
essentially so until it is completed. Every third time a casing is used its alignment is checked and corrected, where required, by inserting shims at the flanged joints.

In relatively tight rock, chilled-steel shot serves as the drilling medium. Where the formation is cavernous, the loss of shot would be so great that its use is dispensed with. To enable the bit to cut in such sections, six tungsten-carbide knobs are welded at equidistant points around its cutting edge. This material is available in various screen sizes, and it has been found that those of 20 to 30 mesh are easiest to apply and give a longer wearing surface than the coarser particles. After such a bit has cut through a broken zone, shot can be fed under it and normal drilling resumed without taking the tools from the hole.

With increased experience, the drillers are quick to notice changes in the character of the rock and to shift from shot to carbide-bit drilling before appreciable quantities of shot are lost. As a result of watchfulness in this respect, the amount of abrasive consumed has been reduced to less than half that formerly required. Also, familiarity with the equipment, improvements in drilling technique, and better organization have combined to bring about greater footage per drill. During January, with seven machines in operation, including one 36-inch and six 48-inch rigs, 1,700 feet of hole was drilled and concreted. During the seven days prior to March 9, when the machines were moved off the trestle and work was suspended for two weeks because of seasonal high water, 745 feet of hole was put down with eight drills. Since the resumption of activities the daily average has been running around 110 feet. The best mark to date for 24 hours was 149 feet, and on numerous days single shifts have exceeded 50 feet. A high mark of 62 feet has been made. For the 15,000 feet of drilling com-

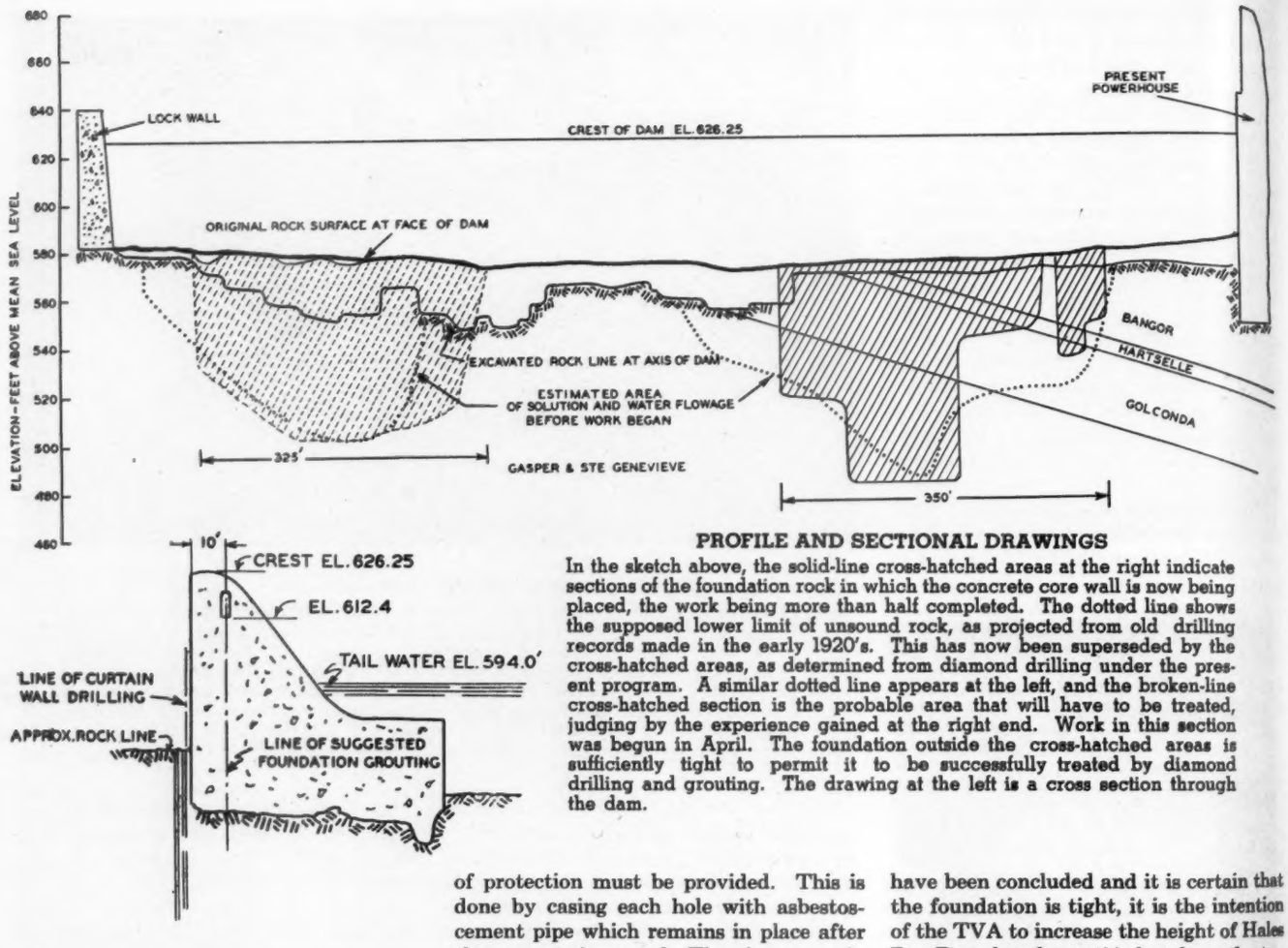
COMPRESSED-AIR SUPPLY

Compressed air is piped to the dam from a compressor plant at the powerhouse end. One of the two units housed there is the Ingersoll-Rand 315-cfm., oil-engine-driven machine shown here. Air-operated drills and paving breakers were utilized in making recesses in the dam in which to set the piers that support the trestle. Compressed air is now used for a variety of purposes, including the operation of hoists, grout pumps, grout-mixer agitators, and other machinery. Air is also employed for testing holes after they are grouted. If leaks exist, air blown down a hole will appear as bubbles in the water of the tailrace below the dam.



ASPHALT CORE SECTION AND SPECIAL EQUIPMENT

Below is a core taken from a creviced zone, showing deposits of asphalt forced into the channels during corrective work conducted in 1925. At the upper left is pictured the cutting edge of a bit on to which six tungsten-carbide knobs have been welded for use in cavernous zones where the chilled-steel shot ordinarily employed cannot be kept under the bit. Soon after the work started, the drills encountered some old steel closure gates that were lying against the face of the dam. After one of them had been cut through, a diver was sent down, and with his assistance the floating crane removed them, as well as a quantity of 4- and 6-inch pipes and fittings.



PROFILE AND SECTIONAL DRAWINGS

In the sketch above, the solid-line cross-hatched areas at the right indicate sections of the foundation rock in which the concrete core wall is now being placed, the work being more than half completed. The dotted line shows the supposed lower limit of unsound rock, as projected from old drilling records made in the early 1920's. This has now been superseded by the cross-hatched areas, as determined from diamond drilling under the present program. A similar dotted line appears at the left, and the broken-line cross-hatched section is the probable area that will have to be treated, judging by the experience gained at the right end. Work in this section was begun in April. The foundation outside the cross-hatched areas is sufficiently tight to permit it to be successfully treated by diamond drilling and grouting. The drawing at the left is a cross section through the dam.

pleted to May 15, the average speed per rig was 5¾ inches per gross operating hour and 7 inches per hour of actual drilling time, including the removal of cores. The machines work between 80 and 85 per cent of the time.

Oil-field-type drill rods of 4½-inch diameter are used, and the service imposed on them is more severe than that to which they are subjected in oil-well drilling even at great depths. When a cavity is encountered and the bit is only partly in contact with the rock, a succession of impacts follows and results in a hammering effect on the rods that tightens the threaded joints to a degree seldom experienced in oil-field work. To break a joint so as to remove the tools from a hole, oil-field-type casing tongs are used.

Holes are carried downward until sound rock is reached, the depth at which it lies having been previously determined by diamond drilling. Some of them penetrate the rock only 25 feet, although most of them go deeper, and some have reached 103 feet, or approximately 158 feet below the water surface. As soon as the last section of core has been removed from a hole, a current motor is lowered into it to measure the velocity of the water flow at various levels. The rate of flow in many of the holes is high enough to wash concrete away, and for that reason some sort of protection must be provided. This is done by casing each hole with asbestos-cement pipe which remains in place after the concrete is poured. The pipe comes in standard lengths of 13 feet, has an outside diameter of 17¾ inches, and is ⅞ inch thick.

Neat-cement grout is first placed in the bottom of each hole through a 1½-inch pipe, after which the casing is introduced. A 6-inch pipe is used to lower it, being screwed into a left-hand coupling which is concreted to a plug at the bottom of it. Sections of 6-inch pipe and of asbestos-cement pipe are added as required until the assembly is long enough. This operation is handled by the floating crane. The liner pipe is, of course, carried only to the rock surface, while the 6-inch pipe is continued to the trestle level. As the interior of the 6-inch pipe is practically dry, the plumb of the hole is checked by lowering into it a flashlight suspended from a wire. More cement grout is then introduced through the 6-inch pipe, after which it is unscrewed from the plug at the bottom of the larger pipe and serves as a tremie for filling the hole with concrete, which is supplied by a small mixer aboard a barge alongside the crane. The average use of concrete is 8 or 9 cubic yards per hole. As soon as the liner pipe is full, the remaining 6-inch pipe section is withdrawn and the 20-inch steel casing is removed.

A force of 200 men is engaged in the work, which is scheduled for completion late in 1942. As soon as the operations have been concluded and it is certain that the foundation is tight, it is the intention of the TVA to increase the height of Hales Bar Dam by about 4½ feet from the top of the 3-foot flashboards now used. This will be done by surmounting the concrete structure with movable gates. The added height will provide for more power generation and will also reduce the amount of dredging required to create a 9-foot navigation channel extending to Chickamauga Dam, 40 river-miles upstream from Hales Bar. The raising of the dam will necessitate building an apron downstream of the structure to lessen turbulence, and this will be done by cofferdamming that area. Cavities underneath the dam will be filled at the same time, probably by placing concrete in Calyx drill holes carried down through the structure.

The work now underway is being done by TVA forces and is under the direction of Lewis A. Schmidt, Jr., who conceived the method being used and developed the specialized equipment needed. He is assisted by A.H. Weber in engineering details and supervision. Frank Miller of Ingersoll-Rand Company assisted in working out the core-drilling procedure and in adapting the design of the drills to meet requirements. H. D. Towers is superintendent and B.W. Crowe, R.M. Winston, and L.C. Tidwell are general foremen. The operations are under the general supervision of Col. Theodore B. Parker and A.L. Pauls, chief engineer and construction engineer, respectively, of the TVA.

Mining Plumbago in Ceylon

John N. Peterson

SORTING GRAPHITE

The material taken from the stopes is sorted underground and again after being hoisted to the surface. The latter work is done by Singhalese women. After being shipped to Colombo, the graphite is once more sorted and graded before being packed for export.

CEYLON is a pear-shaped island just off the southern tip of India and separated from the continent by the Gulf of Mannar and Palk Strait. At its extreme dimensions it is 270 miles long and 140 miles wide, and it is 25,332 square miles in extent, or about three-quarters the size of Ireland. Its population numbers approximately 5,300,000, averaging 208 to the square mile. Colombo, the capital, has about 300,000 residents. The largest group on the island is made up of Singhalese, descendants of colonists from the Valley of the Ganges who settled there in 543 B.C. Ceylon was acquired by Great Britain from the Dutch in 1801.

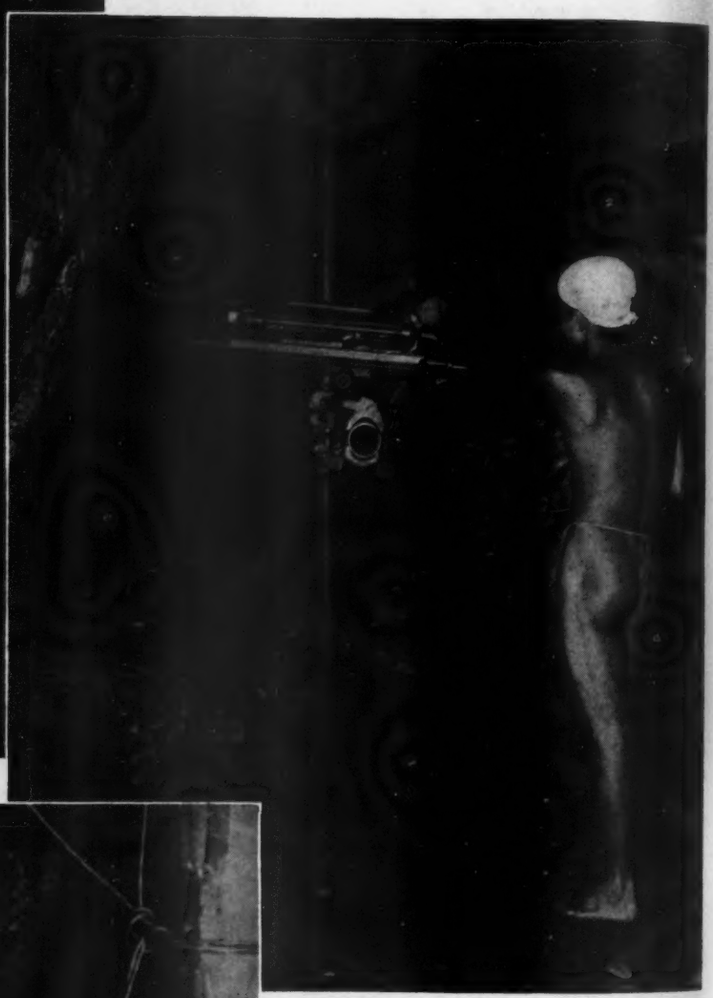
The northern half of the island is generally flat and slopes gently upward to the mountainous southern part which, for a distance of some 50 miles from the coast, also is flat, with a moderate rise to the base of the mountains. An hour's automobile ride from any coastal point in the southern area will take one into the rugged upland region where some peaks reach an altitude of more than 8,000 feet. There the valleys are narrow and steep-sided, and in the streams that radiate in all directions toward the sea are numerous water falls.

In the flat country are the paddy (rice) fields, and there, too, grow cocoanut palms, pineapple plants, and plantain trees. A short distance up the mountain sides is the cocoa- and black-pepper tree belt. Above that are the rubber plantations which, in turn, give way to tea plantations that reach the highest elevations. The uncultivated areas are covered with dense, tropical vegetation that is picturesque and pleasing to the eye. Wild life is abundant, including elephants, panther, deer, bear, and smaller animals. There are more than 370 species of birds, and most of them have brilliant plumage. Pythons and cobras are the principal dangerous reptiles in the jungle, and there are many harmless snakes, as well as the iguana, a large lizard. Precious and semi-precious gem stones are found in the gravel of many of the mountain streams.

The island is composed of ancient crystalline rocks, characterized by well-marked banding or foliation and by wide variation in mineral composition. They are generally regarded as of deep-seated igneous origin, and any that were laid down as sediments have been so greatly metamorphosed and so intimately incorporated in the igneous rocks as to be almost indistinguishable from them. These crystalline rocks belong to the Charnockite series, which also occurs in southern India, and are chiefly classed as fine-grained granulites and gneisses made up principally of quartz and feldspar. In addition to these acidic rocks there are many basic ones such as norites, diorites, and gabbros, with all gradations between them. Interspersed among them are crystalline limestones, and in some areas intrusive pegmatites and small calcareous (tufa) deposits of secondary origin.

In this ancient and twisted shield is found Ceylon's most important mineral product, plumbago or graphite, which is normally shipped to almost every country on the globe. Statistics covering its export go back to 1834 and, as is true of all minerals, its output has fluctuated widely under differing world economic conditions. In 1899 the plumbago industry reached the zenith of its prosperity, and many fortunes were made. Exports exceeded 31,000 tons, and the price was high. The 1906 production surpassed that of 1899, but its value was less than half as much owing to a drop in price. In addition to its best-known use in lead pencils, graphite enters chiefly into lubricants, electrical materials, polishes, paints, crucibles, and facing compounds for foundry molds. The outbreak of the present war stimulated Ceylon's output, so that the 1940 exports amounted to 23,819 tons worth 5,689,357 Indian rupees, or more than double those for 1938 (in normal times the rupee is equivalent to about 36 cents in United States currency).

Graphite is a crystal form of carbon. It is chemically identical with the diamond, but the two are markedly different physically. Graphite is dark and opaque: the diamond is colorless and transparent. Graphite is one of the softest minerals: the diamond is the hardest known substance. Graphite is a good conductor of electricity: the diamond is a poor one. Unlike the latter, graphite crystals are never fully developed, being imperfect 6-sided plates and scales. Graphite has a metallic luster, is infusible and insoluble in acids, is greasy to the touch, soils everything with which it comes in contact, and in many respects is strikingly like molybdenite. Artificial graphite is made from coal or coke in the electric furnace.



OLD AND NEW DRILLING METHODS

The picture at the left shows miners drilling with single-jack hammers and chisel steels. Much of this handwork is still done in the stopes, but elsewhere in the mine it has been supplanted by mechanical drills. These have reduced costs despite the low wages paid labor and have materially increased production. Below, a native is operating a modern drifter drill. The machine at the lower left is an Explorer diamond core drill, the type that is now used for all underground prospecting for new deposits.

Graphite is widely disseminated through the rocks of Ceylon, but all known commercial deposits exist as veins that were formed by the filling of fissures. They are chiefly in the older crystalline rocks where they follow the natural planes of division caused by the banding or foliation. There is generally a main vein, or a system of parallel veins, from which extend stringers or smaller veins. Large pockets are occasionally discovered where fissures widened and thus provided more space. In one locality, veins occur in the pegmatite and are often associated with quartz veins branching off from the pegmatite. They frequently contain pink garnet and are usually rich in iron pyrite, which is more or less decomposed. Along the outer walls is found ferric oxide, which is sometimes intimately mixed with the graphite. Quartz, feldspar, selenite (the cleavage form of gypsum), and other minerals are often present, and occasionally a

DOWN THE HOLE

A group of miners about to be lowered to start work underground. The mine is served by two vertical shafts equipped with steam-driven hoists.

peculiar amorphous substance that is apparently of a carbonaceous nature. The graphite is in the form of crystal plates or flakes which are generally thicker in the bigger veins. The crystals vary in different parts of a vein, being arranged in zones. Large and irregular plates usually occupy the central zone, and in those on either side of a vein the crystal types are the same. In the smaller veins the graphite occurs as small platy needles set at right angles to the walls.

It is not known just how the graphite veins were formed. Authorities seem to be agreed that the material was introduced under high pressure into cracks or planes of weakness in the rocks and that it was either in liquid or gaseous form. Most likely it was of deep-seated origin and was perhaps caused by the decomposition of metallic carbides. There is no direct connection between the vein graphite and that which is widely scattered through the country rocks, but it is believed that they had the same origin.

Ceylon's graphite workings are distributed throughout the mountainous area, and therefore cover nearly the whole southern half of the island. At present more than 2,000 known operations are in progress. Except for three or four properties, they consist of shallow pits or gougings in vein outcrops. They are worked by hand methods by small groups of natives who lease the ground from the owners and sell their production to brokers who, in turn, combine the supply from many sources and sell it to foreign consumers. Although the workings are small, individually, they are so numerous that the aggregate output is an important part of the island's total.

The larger workings are mines, in the true sense of the word, as the veins are followed downward and the ore is won through the usual system of shafts, drifts, winzes, stopes, and other openings. These properties were formerly operated entirely by hand, but machinery has been introduced in recent years and they are now in a transition stage where both mechanical and manual methods are in use. The largest of these endeavors is the Bogala Mine, which will be briefly described. As the mining problems involved there are common to the other workings, this account will be somewhat representative of all.

The Bogala Mine was opened up by M.A. Fernando, a pioneer in the island's graphite industry, and is now owned and operated by his two sons, J.A. and E.P.A. Fernando. They also own nearly 100 additional graphite-bearing tracts. Some of them have been worked from time to time, but since the discovery of the Bogala Mine activities have been confined to it because of the greater richness of the mineral and the opportunity it affords for large-scale production. Today, the output is around 900 tons a month and can be substantially increased.

The mine is located about 50 miles almost due east of Colombo, and is reached from the latter point over a good macadam road. The closest railroad terminal is Avisawella, which is on the line extending from Colombo to Kandy. The name Bogala means bo tree and was given to the property by reason of the fact that a large tree of this species stands near the mine office. The bo tree is sacred to Buddhists because the religion's founder, Gautama Buddha, is reputed to have received his inspiration while meditating under one of them. Most of the miners are Buddhists and they have abiding faith in the power of the bo tree to protect them from the dangers of underground work. Every evening, before the night shift goes on, they gather around it, chant Buddhist stanzas, and offer flowers at the shrine. The ceremony takes place by the light of oil lamps, arranged on a parapet at the base of the tree, adding to the colorfulness of the scene.

The graphite at Bogala is found in a system of generally parallel veins that dip from about 60° to almost vertical. Two vertical shafts have been sunk on the property to a depth of 240 feet and are connected with the veins by crosscuts from which lead drifts with overhead stopes for extracting the mineral. From the first or main level, winzes extend down to additional levels, which are spaced up to 80 feet apart. In this manner a total depth of 800 feet has been attained and nine levels have been established. Crosscuts interconnect the winzes on each level.

In the early stages of mining at Bogala all work was done by hand. As depth was gained, a hoisting problem developed, and in order to cope with it the two shafts were provided with wood-fired boilers and steam-engine-driven hoists. Later on, when water was encountered, steam-driven pumps were installed to handle it. At first only the most accessible deposits were worked. Because of this, and the availability of cheap labor, hand mining sufficed. But in recent years operations have reached a stage where it is no longer practical. The workings are deeper, crosscuts are longer, and the cost of labor is rising. For these reasons air compressors and rock drills have been added to the equipment and have helped to reduce outlays and to increase production.

FIRING A BOILER

Steam is generated by wood-burning boilers. In addition to operating the shaft hoists, it is used underground to run some of the pumps and some of the hoists that serve winzes.

By the old procedure of exploring for additional parallel veins, a 5x6-foot crosscut was driven by hand. The average rate of advance was 12 feet a month, and at such a slow pace costs were high even though labor was cheap. Diamond drills were adopted for this work of prospecting, and they will drill 10 feet in eight hours. If a paying deposit is found, a crosscut is driven to it with drifter drills at the rate of 5 feet per 8-hour shift. Drifts also are driven with drifter drills, while Jackhammers are used for sinking operations and for some stoping. Much stoping is still done by hand methods.

All hoisting through the winzes was originally done with hand-operated windlasses many of which gave way later to steam-engine units. More recently, however, both are being replaced by pneumatic hoists. Air-driven pumps are employed in shaft sinking, and in some cases are being substituted for steam-driven ones. The growing use of compressed-air equipment is improving underground working conditions. The elimination of steam pipes and the exhaust of cold air from the air motors and drills makes for cooler and better ventilation. On the surface, air-operated equipment includes sharpeners, grinders, and air-oil furnaces for taking care of drill steel, and pneumatic tools for general repairs in the workshop and elsewhere about the property. The mine is lighted with electricity generated by diesel-engine-driven units.

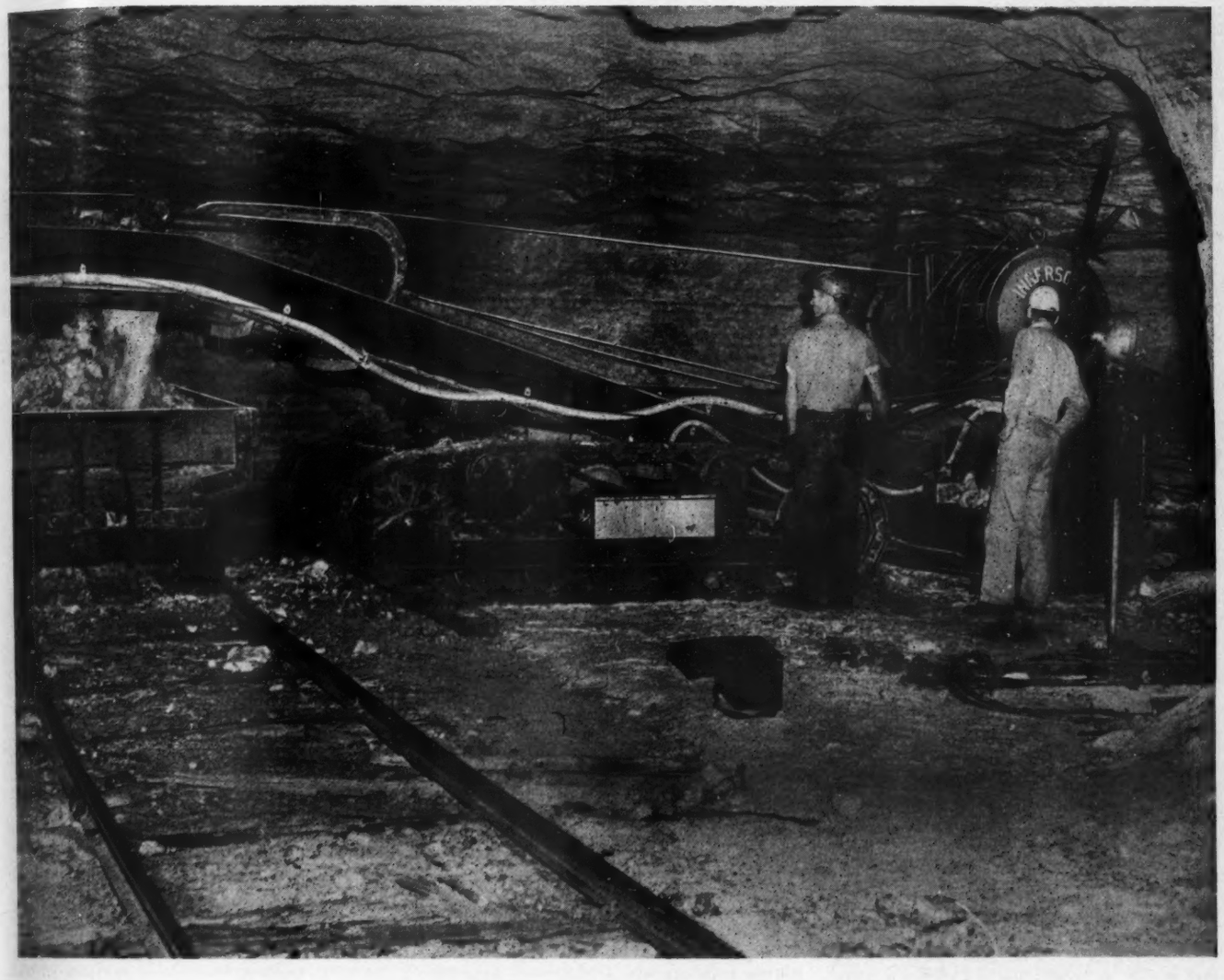
Ventilation is provided by arranging one shaft and series of winzes for downcast circulation and the other series for upcast circulation. Doors and partitions in the mine help to direct the air currents as desired to assure maximum ventilation. The steam pipes for underground service are placed in the upcast shaft and winzes and the heat they give off tends to increase the velocity of the upflowing air.

Most of the workmen are Singhalese and Tamils and a good many of them are from neighboring farms. As a class, they are willing and, given proper training, quickly acquire a working knowledge of the mechanical appliances and methods. The management provides good housing facilities, a reading room, and recreation clubs. Popular sports are volley ball and boxing. A Singhalese Dramatic Society is run by the men under the direction of a member of the management staff and puts on productions at regular intervals. Numerous modern safety measures have been introduced, including telephonic communication within the mine. Two physicians are in attendance to look after the health of the men, and the government medical officer in the area visits the mine periodically. A first-aid station is maintained for cases of minor injury or illness. Radio loudspeakers are set up at various places around the property and enable the men who are off duty to hear news broadcasts and music. Attention is also paid to the religious needs of the workers. Every Full Moon Day they assemble under the bo tree where a Buddhist *bhikkhu* (priest) talks to them on the five precepts of the Lord Buddha. Sermons on Buddhism likewise are broadcast.

Before being brought to the surface, the graphite is hand sorted, and it undergoes further sorting and grading after being hoisted. Grading consists of segregating the material according to color, size, and quality of the pieces. The product is stored in stock sheds, from which it is trucked to Colombo. This method of transportation has supplanted a very primitive one. Before automotive equipment was available, the graphite was carried by laborers a distance of 3½ miles from the mine to a road, where it was transferred to bullock-drawn carts which took several days to make the trip to Colombo. There the graphite is again graded by combined manual and machine methods. The larger lumps are prepared by women workers, while the finer material goes to a sifting machine that separates it into small lumps, chips, dust, and flying dust. Until of late, most of the supply has been sold to the United States and Japan.

MINE OFFICIAL

Superintendent George, who also serves as mining engineer, standing in front of an Ingersoll-Rand 210-cfm. portable compressor that supplies some of the air for running drills, hoists, pumps, and other equipment.



MOBILE-SLIDE LOADING UNIT

A 3-drum hoist and inclined slide mounted on crawlers and used for loading cars. This outfit handles up to 145 tons an hour, and in favorable material with adequate hauling facilities will load from 800 to 1,000 tons per shift.

Scraping and Loading in Mines

R. V. Pierce and R. N. Bryan

IT IS said about the science of medicine that important discoveries are sometimes made years before their widespread acceptance by physicians, hospitals, and medical associations. This is doubtless true in other fields of science, for the average professional man is reluctant to stake his career on something new until the discovery is thoroughly tested over a period of years. History is replete with its Pasteurs, its Robert Fultons, its Alexander Bells, its Edisons, and its Wright Brothers—all of whom suffered many rebuffs before convincing the public that they were men of sound mind.

It is virtually impossible to name the man who invented scraper loading—a practical, cost-saving development now widely used in the many fields of mining; but we do know that the inventor's idea was once kicked around like an unwanted stepchild. So far as we can learn, the earliest application of slip-scraper mucking occurred in an Idaho mine during 1898. For the next few years the history of scraper mucking is obscure; but it is known definitely that in the early 1900's J. George Leyner of Denver, Colo., was working on plans for much better methods and that those plans were laid aside for a period of years. During the course of his work, Leyner designed the Little Tugger, an improved type of portable hoist which he did not immediately offer for sale because of lack of a market. He had the foresight, however, to file away his drawings, and later these became the basis of the Ingersoll-Rand Little Tugger, which was introduced in 1912.

The original Little Tugger was a 2½-hp. single-drum hoist that was used for pulling loaded hand-held scrapers from the faces of various underground workings such as stopes, drifts, and production areas generally. Because of the single-drum feature, the scraper could be moved back to the face only by manpower. This proved to be expensive, and it meant undue fatigue on the part of the operator. Nevertheless, it was a step in the right direction, for it induced more thought,

TYPES OF SCRAPERS

The open hoe type (upper left) is the basic design of most of the scrapers used. It is suitable for handling coarse, chunky material, where side plates would cause it to ride over the pieces and prevent the cutting edge from digging in. In fine material, on the other hand, the open-type scraper loses its load, so side plates are added to form the full-box unit shown above. For material of intermediate size the partial-box type (left) is acceptable. There are countless other modifications to meet specific conditions

more experiment, more refinements in design.

As an indication of the problems that confronted scraper operators twenty years ago we quote from an article written by Mr. Lucien Eaton in 1921:

"The 'slusher' is hauled to the chute or car by a small Ingersoll-Rand 'Little Tugger' hoist, developing about two and one-half horsepower, and is dumped by hand. It is dragged back to the ore-pile by hand and filled in the usual way. The work is done by the miners, one running the hoist and the other handling the 'slusher.' As handling the 'slusher' is hard work, the men change off at frequent intervals, and so avoid excessive fatigue . . . .

"In this case the 'slusher' holds three cubic feet and usually pushes another two cubic feet in front of it. The hoist can develop a pull of 800 to 1,000 pounds and has a speed of 80 to 90 feet per minute. The rate of loading is ten to fourteen tons an hour for short periods, and the effective limit is about 50 feet from the chute. . . .

"The advantages of this system are its simplicity and low cost. After the blast, no time is lost in rigging up, and, when the bulk of the broken ore has been moved, the edges of the pile and the ore scattered in other parts of the stope are easily cleaned up. The disadvantages are that the physical labor entailed is hard and only men of strong physique are able to make a success of it. Furthermore the loading speed and the effective radius are not large."

The comments of Mr. Eaton, a prominent mining engineer and consultant, are worthy of mention, for they emphasize the difference between the scraper methods of twenty years ago and those of today.

In 1920 and in the years soon following, numerous developments occurred—developments which included double- and 3-drum hoists, scrapers of better design, higher rope speeds, and special accessory equipment. Today, scraper hoists are available in sizes ranging from 3.5 to 100 hp. and with "pull" rope speeds as high as 450 feet per minute and "pull-back" speeds as high as 600 feet per minute. It is now possible to obtain a hoist for any kind of scraper work—from the "babies" to the powerful electric-driven models that are used for large-tonnage operations.

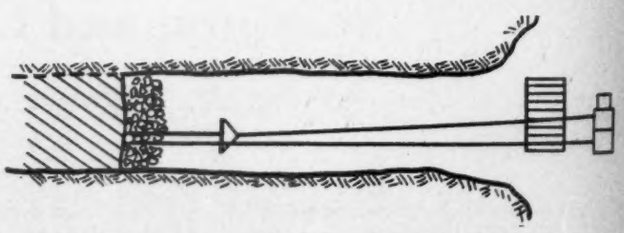
As a result of these improvements, scraper loading is now widely accepted in practically all fields of underground mining. In the past, emphasis has been placed on better powder, drills, and steel, more efficient haulage and milling practices, etc. More recently, scraping has been recognized by manufacturers and operators to the point where the latter are laying out mining methods so as to take advantage of the savings the equipment offers, and manufacturers are coöperating by building equipment to fit the operators' needs, namely, peewee hoists and remote-control and automatic-transfer units.

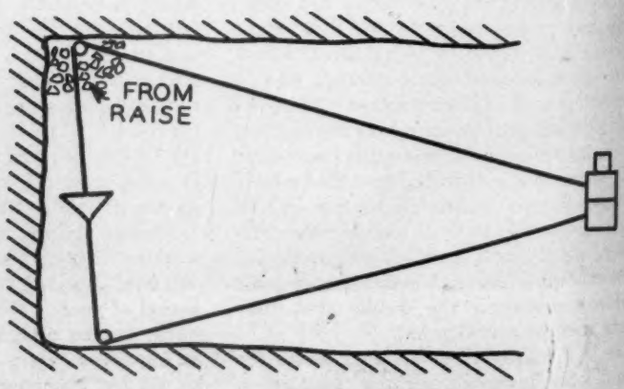
Several of the reasons underlying the acceptance of mechanical scraping are beyond dispute, and are as follows:

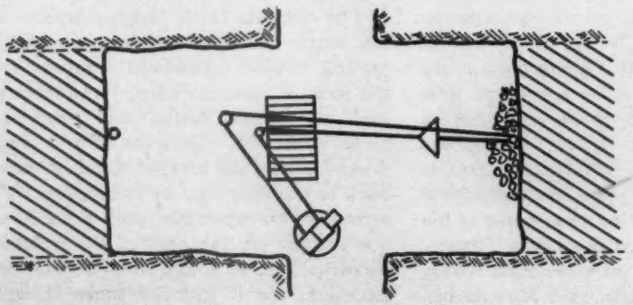
1—Modern scraper methods eliminate

DOUBLE-DRUM HOOK-UPS

The sketch at the right illustrates the essentials of a scraper-hoist layout for use in narrow areas. A cable is run from one of the hoist's drums to the bail or forepart of the scraper and another cable, attached to the scraper's tail, passes around a sheave block anchored at the mining face and runs thence to the second drum. The ore is pulled to a grizzly, or barred opening, in front of the hoist, which may be fastened to timbers, braced or spragged against a side wall, roof, or bottom, or attached to some sort of a foundation. Below is shown a hoist mounted on a turntable to permit mucking either end of a mining section. In the other drawing the sheaves are arranged to pull waste fill to a corner of a worked-out area.







the necessity of moving and loading broken ore or rock by hand.

2—Scrapers can move large, unwieldy chunks of ore too heavy to be lifted manually.

3—War production requires speeding up—more metal per man-shift. To get metal, more ore must be handled per shift at the primary source—at stopes, etc. This is where the scraper is right at home.

4—In view of the shortage of experienced men, it is sometimes necessary to hire laborers who are not accustomed to underground work. It is therefore essential that trained men do the work for which experience is needed and untrained men the work that is easy to learn, such as scraper loading.

5—Scraper loading has eliminated much of the block-holing formerly required in mining large ore bodies.

6—Speedy working of an ore block often shortens the time the area has to be kept open, thus effecting savings in timbering and supplies, as well as preventing recurrent repairs. Materials are costly and hard to obtain under present war conditions.

7—Mechanical scraping contributes to the safety of the workers because they spend less time in open areas when using a hoist-scraper hook-up for mucking operations.

8—Scraper mucking set-ups are flexible—they can be used both when stoping and when driving headings.

Scraper loading constitutes but one phase of the mechanization that has been taking place in mines during the past several decades. It is, however, one of the most important aspects, in that it lowers costs in several ways, namely:

The operation of a mechanical scraper is very simple. It does not require a long educational plan. Nearly anybody can handle one after a few minutes' supervision.

The initial cost of a hoist-and-scraper hook-up is considerably less than that of other loading and conveying machinery. The equipment is not complex, and it has few exposed working parts.

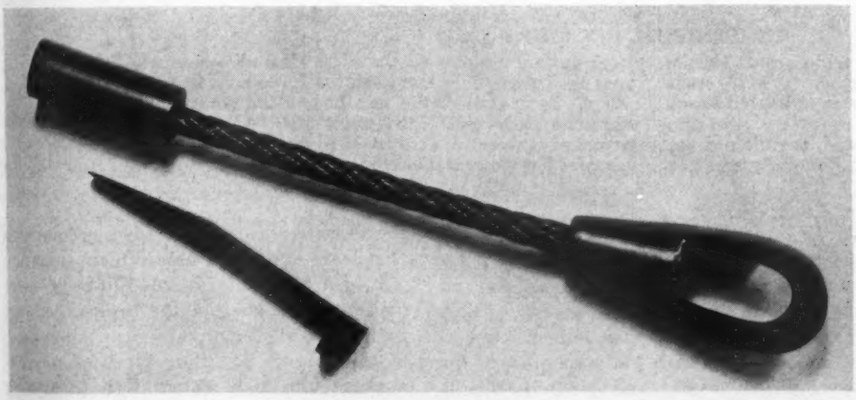
Such a hook-up needs less maintenance—fewer repairs. In heavy ground the working parts of the hoist unit are under cover; only the scraper and the sheaves—which represent a small portion of the investment—are out in the open. Modern scraper equipment is rugged—durable—and in the event of roof falls is less likely to be damaged than a more elaborate conveyor system.

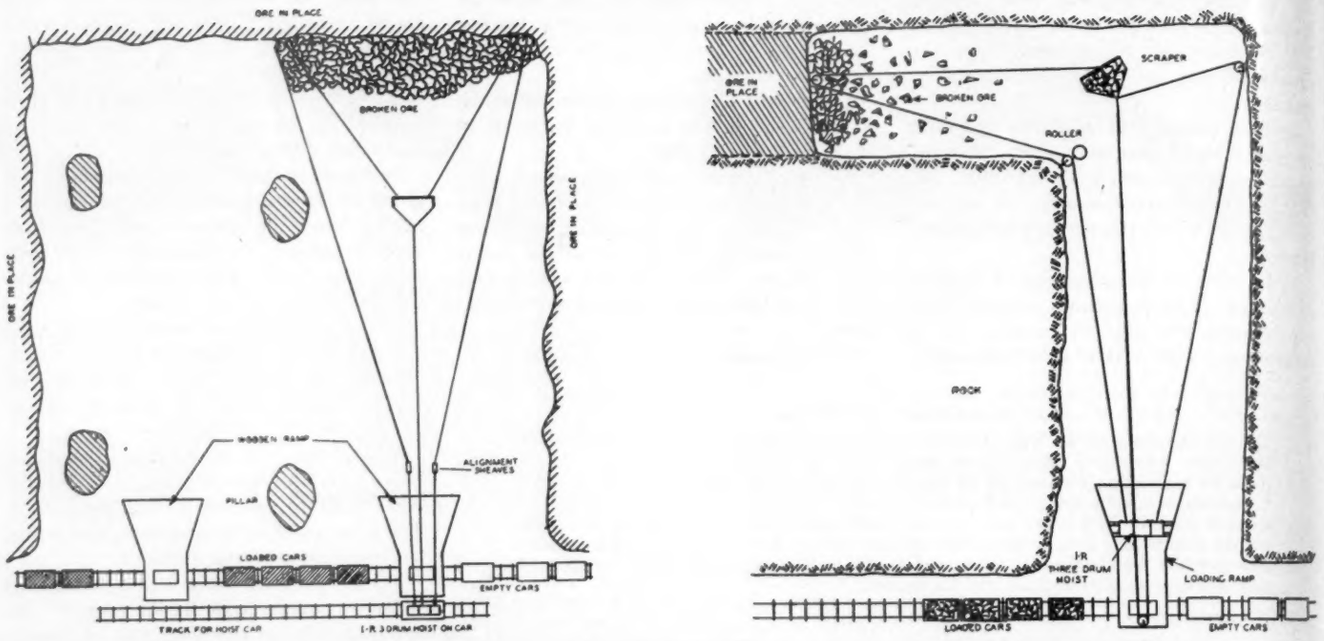
Here, again, safety is a factor. The men are in untimbered areas but a fraction of the time they have to remain there when hand mucking is used, or where the machinery is such that the operator has to be at the face when loading.

Finally, in the smaller sizes, it is possible to obtain either compressed-air hoists

FLEXIBLE EYEBOLT

The tail sheave must be well anchored to withstand the pull from the hoist when the empty scraper is being drawn back to the muck pile. The flexible eyebolt pictured below can be used for an anchorage in hard or reasonably firm ground. It consists of a standard closed socket attached by a short piece of wire rope to another socket. The latter will fit into a drill hole, and is secured by driving a wedge alongside. Anchorage holes may be drilled at any angle, as the flexible rope permits the sheave to adjust itself to the angle of the pull line. The bottom view shows a sheave hooked into the socket.





THREE-DRUM HOOK-UPS

Although 2-drum hoists are most frequently used, 3-drum types are becoming increasingly popular in wide areas and for special applications. The drawing at the left shows an arrangement for mucking a large room in a lead-zinc mine. The hoist is mounted on a car, and its middle drum pulls the scraper up a wooden slide and dumps its load into a car spotted underneath the slide. The alignment sheaves near the latter guide and keep the scraper in line with the ramp. By means of the end drums the scraper can be worked to any part of the muck pile. A special hook-up for mucking around a corner is illustrated at the right. In this case the hoist is mounted on the slide.

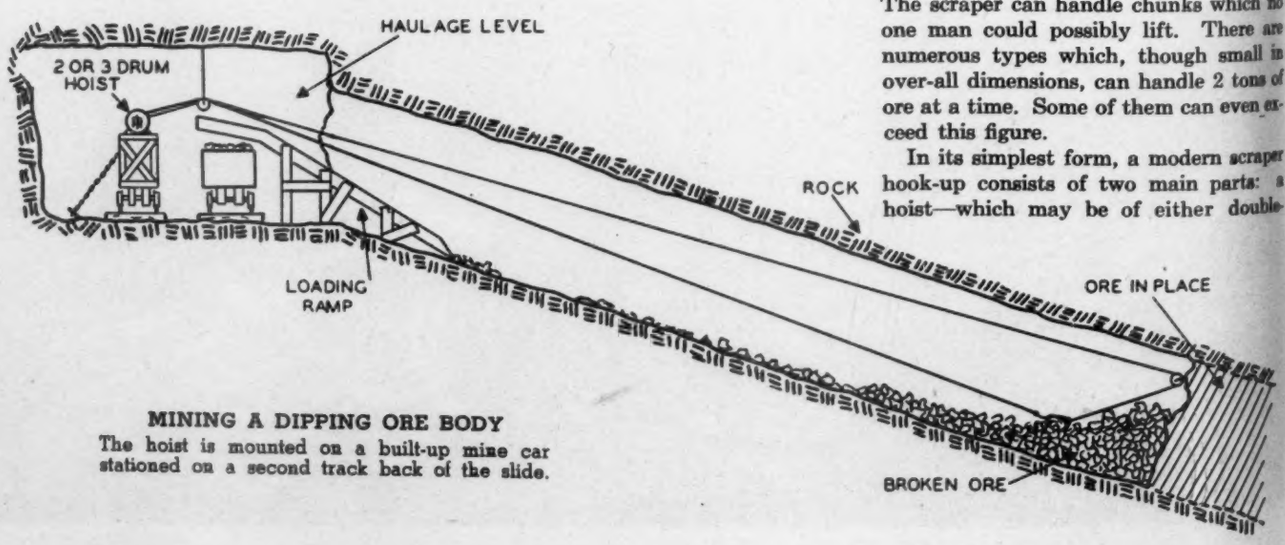
or electric hoists. In this connection, interchangeability of motors is an important feature. By changing the motor, one and the same hoist can be operated by either air or electricity. This latitude often results in important economies, for it means that the hoist will fit into the general scheme of things no matter which power of the two is available.

Loading ore necessarily involves not only loading but also transportation. In a stoping operation, ore has frequently been loaded into a car or wheelbarrow and then transferred to the chute or dumping location. With a hoist-drawn scraper, these two jobs are done in one operation.

In recent years it has been shown that substantial savings can be realized by using larger hoists and scrapers and, in many cases, higher rope speeds. This makes it feasible to open longer sections of an ore body with less expenditure for development work, and permits operators again to cut costs and to place vital ore into production more quickly. These economies, combined with the obvious advantages listed previously, have convinced even the most skeptical mining man that scraper mucking and scraper loading are often essential in present-day operations.

Before going further, it might be well to describe briefly the loading methods that were employed before mechanization gained a foothold. In the old days, after drilling and blasting, the broken ore had to be shoveled manually into mine cars, wheelbarrows, or other types of conveyances. The men who did the shoveling were known as muckers. This work generally served as the introductory phase of mining for the employee working underground for the first time. Also, it was usually the spot where mining students—the future operators and engineers—received their initiation into the mining profession. Modern scraper methods have, of course, eliminated most of this back-breaking, time-consuming shovel work. The scraper can handle chunks which no one man could possibly lift. There are numerous types which, though small in over-all dimensions, can handle 2 tons of ore at a time. Some of them can even exceed this figure.

In its simplest form, a modern scraper hook-up consists of two main parts: a hoist—which may be of either double-



MINING A DIPPING ORE BODY

The hoist is mounted on a built-up mine car stationed on a second track back of the slide.

or triple-drum construction—and the scraper itself, which is made up of a scraper blade, a bail or tongue, and side plates of various sizes and shapes. There are also other types of scrapers, some of which are crescent-shaped. Now let us assume that the scraper is loaded with material that has been blasted from the face or ore body. Assume, too, that the scraper is being drawn toward the hoist by the rotation of one drum which is winding in cable. The second drum, with clutch disengaged, is of course paying out cable. When the scraper reaches the grizzly (the barred opening above a chute) the ore drops between the bars into a storage pocket or a waiting car. The scraper is then ready for a return trip to the face. The hoist operator disengages the clutch of the first drum and engages the clutch of the second drum, which at once begins to wind in cable, thus drawing the empty scraper back to the face where loading is repeated.

It will be noted that, although a hoist is used in the scraping operation, nothing is actually hoisted or lifted. Through the action of its drums it merely pulls or drags. As a matter of fact, the hoists designed for this service are special machines that are compact in order to make them portable. This feature of portability is vital to successful underground work. A great many double-drum hook-ups are possible, and a few of the commoner ones are illustrated. However, though details vary, the basic principles just outlined apply to practically all of them. A 3-drum hoist permits even greater flexibility of movement than a double-drum unit. As will be seen in the accompanying diagrams, it is possible to lay out the system in such a way that the scraper can be pulled in several different directions and shunted about like a freight car from main line to siding. The advantages of this are obvious.

In describing the simplest form of hoist-scraper hook-up in connection with one of the line drawings, we pointed out that the hoist may be fastened to a foundation on the ground. Although this is frequently done, it can, for example, be mounted over the slide of a mobile or stationary loading ramp, on a built-up mine car, or on a wooden pillar or column. The exact type of mounting is determined by convenience, accessibility, the need of portability, and other factors.

So far we have mentioned only the actual mechanics of scraper loading. A natural question would be, "How does the scraper dispose of the ore, and what happens then?" Clearly, the problem of transportation has just begun when the scraper relinquishes its load. "What becomes of the ore after the scraper has moved it from the face to some specified point near the hoist?" A number of things may take place, of which the following are three examples:

The ore can be loaded into skips or into elevators.

It can be dropped through a grizzly into a storage pocket, there to await dumping into mine cars.

It can be loaded directly into mine cars with the aid of a permanent or mobile slide or ramp. When the latter method is practiced the hoist is often mounted on the frame of the slide and is, of course, placed in such a way that it will not interfere with the movement of the ore.

Slides used for loading ore into cars may be divided into two main classifications: mobile slides mounted on wheels or crawlers, and stationary ones more or less permanently attached to the ground or to mine timbers. In some instances a slide with a long horizontal section is built over the mine track so that cars can be spotted, one by one, beneath an opening at the rear end of the horizontal member and filled. The angle of the loading slide in relation to the track surface often varies from 20° to 30°, depending upon local conditions. Over-all dimensions of the slide and the scraper also are influenced by these factors. The hoist is usually mounted on top of a frame; but, where the headroom is low, it may be fastened underneath the slide. In that case the hoist must be provided with end control within reach of the operator standing alongside the slide.

The photographs and drawings used in this article were obtained from Ingersoll-Rand Company and appear in its 184-page book entitled, *Modern Methods for Scraper Mucking and Loading*.

LIGHTWEIGHT UNIT

At the right is a 3-hp., 2-drum air hoist operating a 26-inch scraper in a western gold mine. The hoist has a rated cable pull of 850 pounds with air at 80 pounds pressure and an average cable speed of 125 feet per minute. It is handling about a wheelbarrowful of ore each trip. The other picture is a side view of the loading slide used in connection with it. This lightweight scraper-loading outfit is the only type of mucking equipment suitable for drift or level loading that can also be taken into stoping areas. The hoist, without cable guides, weighs 250 pounds and will pass through an opening of 13x15 inches.

Opening Montana Chromite Deposits

Wesley J. Moore

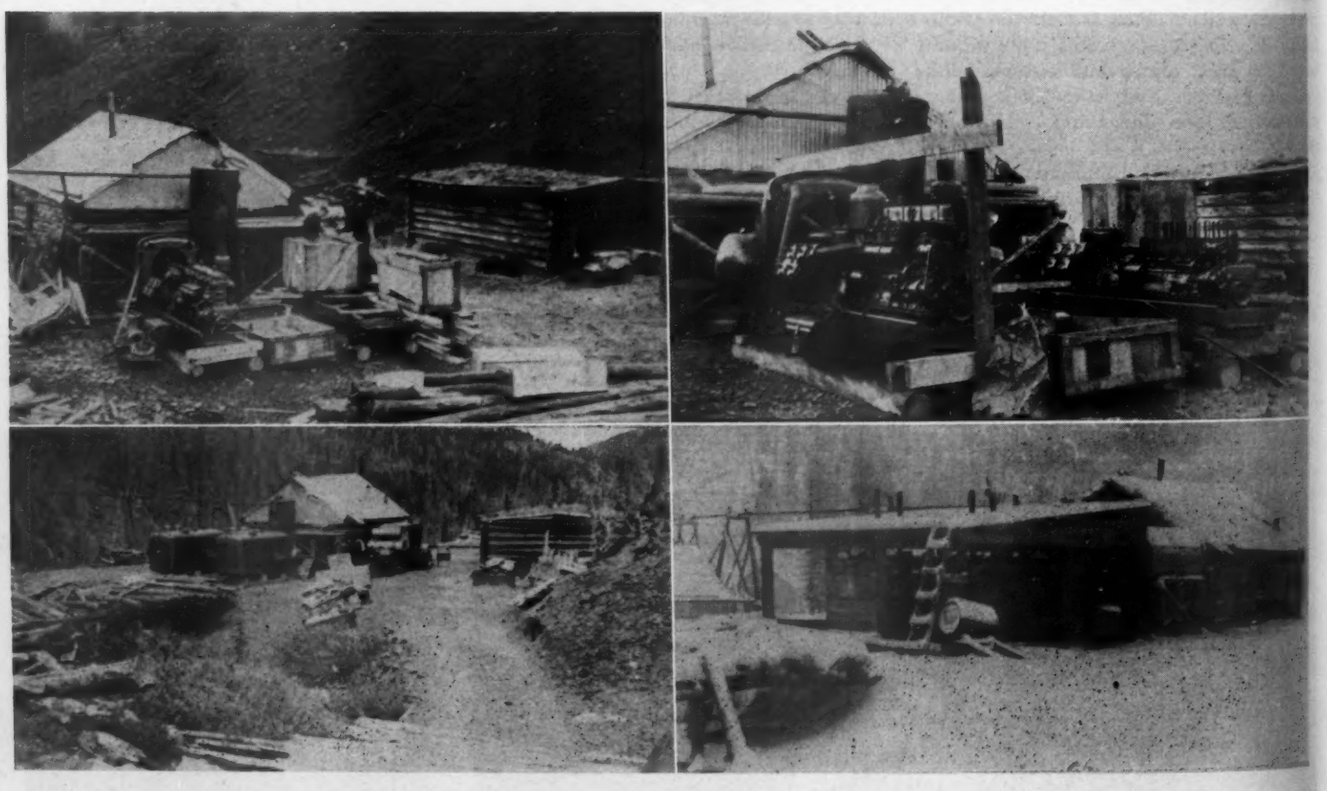
CHROMIUM was a metal of relatively little importance until the first World War brought about its use as an alloying element for steel. World production of chromite, the ore from which the metal is obtained, rose to a maximum of 283,000 tons during the war period. Since then there has been a gradual increase in chromium consumption, its three principal fields of application being metallurgy, chemical manufacturing, and refractories. The current world output of chromite is reported to be at the annual rate of 1,200,000 tons of ore containing 48 per cent chromic oxide.

The addition of a small percentage of chromium to steel gives an alloy of intense hardness and with a high limit of elasticity. High-speed cutting tools, bearings, crushing and grinding machinery, safes, armor plate, and armor-piercing projectiles are typical products that use this grade of chrome steel. The addition of somewhat larger percentages of chromium to steel results in a corrosion-resistant alloy. The grade of stainless steel that is most widely employed contains 18 per cent of chromium and 8 per cent of nickel, but there are numerous other combinations. These various alloys—first popularized in cutlery—have been used for making many machine parts such as engine and compressor valves and have found considerable application in industry and in construction.

Chromium plating, especially of automobile parts, is familiar to everyone. Aside from good appearance, chromium plate possesses the attributes of resisting acids and alkalies and of being extremely hard, even when thin in section. The resistance of chromite to heat and to chemical action has led to its use instead of magnesite as a refractory for lining open-hearth furnaces. Chromium compounds are employed to advantage in tanning hides because they materially reduce the time of tanning and produce a leather that withstands acids and water. Various other chromium compounds serve the arts and industries.

Although the United States has consumed half or more of the world's output of chromium for many years, it has never produced more than a small fraction of its needs. Turkey, New Caledonia, and Southern Rhodesia have been the principal sources of supply, towards which Russia now and then made important contributions. Cuba and Greece constituted secondary sources. More recently the Philippine Islands became an important producer, with virtually all the output going to the United States.

With the outbreak of the present conflict the demand for chromite rose abruptly as a result of stimulated chrome-alloy steel production in Europe. In the United States, chromite was one of four minerals placed in the first priority class for stockpile accumulation under the Strategic Minerals Act, and imports in 1940 were double those of 1939. At the same time, increasing amounts of the chromium consumed by us were being diverted to the



SCENES AT BEN BOW

Whenever a new mining property is opened up, the first machines required are usually the air compressors to furnish power for operating rock drills. These prospects are often located in isolated, rugged areas with poor roads, so that real difficulties have to be surmounted in delivering and setting up the machines. These pictures were taken during the erection of two Ingersoll-Rand portable compressors after they had been hauled 40 miles from the nearest railroad point to a remote mountainous section of Montana where deposits of chromite are being opened up. To facilitate transportation, the machines were shipped from the factory in dismantled form, the consignment consisting of 30 boxes and the unboxed frames, none of which weighed more than 2,500 pounds. Some of the boxes are visible in the upper left-hand view where one compressor is shown partly assembled. The crude timber frame that was used to help lift the parts is seen at the upper right. The two compressors were set up and checked in eight days and furnished all the air for drilling and accessory operations until a stationary unit could be delivered and erected. Before the first snowstorm came in September a roof was placed over the portables (lower right).

steel industry, thus reflecting the importance of the metal in the defense program. A considerable proportion of our ferrochrome alloys went to Great Britain and her dependencies and to Latin America. Chromium was put under full priority control last July, and its use for nondefense purposes was restricted. The official figures then released placed the annual consumption of chromite at from 750,000 to 800,000 long tons. Approximately 2½ tons of metallurgical-grade ore are required to make 1 ton of ferrochromium, in which form the metal is chiefly utilized for making chrome steel. Ferrochromium contains between 60 and 70 per cent pure chromium.

In the face of the growing importance of chromium and our dependence upon sources of supply outside our own continent, the Government took steps to find and develop domestic ores. This work was conducted by the United States Bureau of Mines and the United States Geological Survey, the Strategic Minerals Act having made available for the purpose the sum of $500,000 a year for four years beginning on June 30, 1939. Among the districts explored with success by the Bureau of Mines was Stillwater County, Montana, where trenching and diamond drilling disclosed the presence of a large tonnage of chrome ore.

Development of the deposits was started last summer by the Anaconda Copper Mining Company under a management agreement with the Defense Plant Corporation. What is known as the Ben Bow property is being operated by that company for Metals Reserve, which supplies the needful funds and takes the concentrates produced. The other location—the Stillwater property—is being developed under similar arrangements. Although this venture is still primarily in the exploratory stage, plans are being drawn to make it the major chrome-producing center of the area.

AT THE STILLWATER PROPERTY

A single 500-cfm. Mobil-Air unit was initially set up here and was later supplemented by one of the machines originally used at Ben Bow. These pictures were taken during the freighting and erection of the first unit.

Owing to the inaccessibility of the deposits and the urgent need of getting them opened up as quickly as possible, it was decided to utilize portable air compressors until such a time as larger stationary machines could be brought in and set up. Three Ingersoll-Rand HK-500 Mobil-Air units were hauled to the sites over roads that were little more than trails. Two of them were originally taken into the Ben Bow property and one into the Stillwater claims. Because of the difficulties imposed by the terrain, their transportation and erection entailed careful planning, the exercise of considerable resourcefulness, and much physical effort. Both properties are situated in the Stillwater complex, a 30-mile strip running north of the Beartooth Mountains. The Ben Bow acreage lies at an altitude of from 8,400 to 9,000 feet and is some 40 miles from the nearest railroad point. The Stillwater prospect is in the same district and at an elevation of approximately 7,500 feet.

The two portables for the Ben Bow site were shipped via the Northern Pacific Railroad to Columbus about the middle of last June. To facilitate delivering them from railhead to their destination, each unit was broken down at the factory in Painted Post, N.Y., representing a consignment of fifteen boxes of parts and the unboxed frame. All cases were made up the same as for export shipment, each being mounted on heavy skids and the contents wrapped to protect them from exposure to bad weather. The thirty boxes and two frames were trucked from Columbus to Dean, a small post-office point 32 miles distant. The Ben Bow property, approximately 9 miles from Dean, is reached by a wagon road which, at that time, was very rough, with steep grades and sharp curves. Rubber-tired wagons drawn by either four horses or by a small rubber-tired tractor were used for the final stage of the journey. The time per trip to the mine averaged three hours, although the maximum wagon load was 2,500 pounds, and in most cases only 1,000 pounds. The road was in an unusually bad condition as a result of a week of steady rain.

At the erection site the boxes were unpacked and the assembly of the compressors was started. Lifting apparatus was lacking, so all parts were raised and placed on the frames with the aid of crib-

TRANSPORTATION EQUIPMENT

To lighten the load as much as possible, the compressors were hauled piecemeal from Dean to Ben Bow, a distance of 9 miles, in rubber-tired wagons drawn by a small rubber-tired tractor or four horses. The average load carried was 1,000 pounds and the average time required for the trip was three hours. The consignment consisted of 32 pieces.

bing and bars. The foundation for each machine consisted of timbers hewn from trees cut down on the property. To add to the difficulties, it rained every day. Despite the obstacles encountered, both units were set up in six days, and two more days were spent in checking their operation. Both portables were connected to one receiver, from which approximately 3,000 feet of 4-inch pipe was laid to proposed working areas.

The batteries for the compressors had been shipped dry, which is the usual export practice. This created a problem; but finally 2 gallons of sulphuric acid were obtained from a creamery in the Town of Absarokee and snow was melted to provide pure water. No measuring vessel was available with which to proportion the acid and water to obtain an electrolyte of the correct specific gravity, but this difficulty was overcome by using some empty whiskey bottles. The two batteries supplied current for the first electric lights in the camp—12-volt, 25-watt bulbs being hung from two drop cords.

Standard Oil Company of Indiana furnished fuel and lubricants for the compressors. During the first few weeks, until a 500-gallon storage tank could be built and connected by gravity feed lines to the fuel tanks on the machines, Stanolin high-speed diesel fuel was freighted in in barrels. Polarine lubricating oils were used at the start: S.A.E 10 for the compressor end and S.A.E. 30 for the engine end. Later on, Stanoil 25 and Standard heavy-duty truck and bus oil, respectively, were substituted for them. Engine oil was changed every 100 hours of operation, and compressor oil every 200 hours. A total of 25,000 gallons of fuel oil was consumed without replacing the original engine filters and without an enforced shutdown.

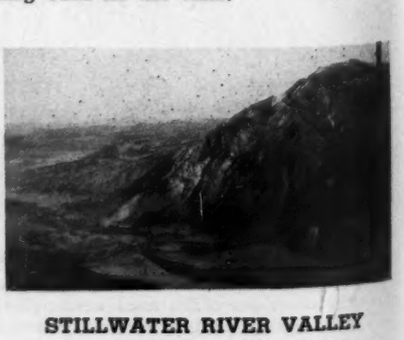
From June 23 to November 15, the portables worked from 3,000 to 3,500 hours without a breakdown. During the final two months of the period they ran 24 hours a day at 80 to 90 per cent of full load, being stopped only to change lubricating oil. For a little less than five months they supplied all the air required by drifter, stoper, and Jackhamer drills, mucking machines, air hoists, air-operated pumps and fans, and blacksmith-shop equipment. In that space of time a total of 5,600 linear feet of drifts and raises was driven to open up the chromite deposits.

The HK-500 portable for service at the Stillwater property was delivered and set up last September. It was shipped fully assembled to Columbus; but the condition of the roads over which it had to be hauled was so bad that it had to be dismantled for the final leg of the trip. The largest piece, consisting of the frame and engine block, did not weigh more than 3,000 pounds. All parts of the machine were boxed, with the thought in mind that they might be skidded up the mountainside that had to be negotiated to reach the location. They were trucked from Columbus to a base camp at Mouat's Ranch, from which point they had to be taken in over a trail having grades up to 40 per cent. While the compressor was being taken apart, work was in progress on the trail to widen especially narrow sections and to reduce the sharpness of the worst of the curves.

The erection site was approximately 2 miles from the base camp and on top of a mountain. The lighter boxes were transported in small 2-wheeled trailers drawn by Caterpillar 20 and RD-4 tractors. The frame and engine block were hauled up in a larger trailer. The machine was delivered at the chosen spot without the necessity of skidding any of the parts and was set up in a clearing made with a bulldozer mounted on a tractor. As at Ben Bow, no lifting tackle was available; but the unit was assembled and ready for operation in 2½ days. Two-inch pipe lines were run from the receiver to the locations of proposed adit portals. Later on the compressor was inclosed in a building that also serves as a blacksmith shop. A 3,000-gallon tank was erected for fuel-oil storage.

To effect a permanent installation at Ben Bow, an Ingersoll-Rand Class PRE synchronous-motor-driven machine of 1,500 cfm. capacity was ordered. This was delivered and set up last fall, being ready for service on November 15. One of the two portables was left at the property for standby service in case of power failure, while the other one was moved to the Stillwater site to provide additional air capacity there. It was desired to transport the unit remaining at Ben Bow a distance of 1½ miles to the portal of No. 4 Adit, while the compressor consigned to Stillwater had to be transferred some 30 miles by road. Just how these moves were to be made was not entirely clear to those to whom the job was assigned until a snowstorm followed by freezing weather simplified the problem.

The machine left at Ben Bow was transported on its original skids to its new station without difficulty. As the unit for Stillwater had to go out by the same route, it was also skidded to the No. 4 Adit. There it was mounted on heavier skids made up of 8x8 timbers, loaded on a truck, and hauled to the base camp at Mouat's Ranch. As the trail had been improved since the first compressor was taken up the mountain, and as there was ample snow on the ground, it was decided to skid the machine to the mine without dismantling it. Two tractors were hooked up in tandem and succeeded in drawing it to the mountaintop in two hours. No trouble was experienced; but it was found that the skids had been worn down 2 inches. The portable was placed alongside the one erected in September, and the two now operate alternately, each on an 8-hour shift. This arrangement will be continued until the demand for air necessitates running both all the time.



STILLWATER RIVER VALLEY

Compressed-Air Gun Used for Movie Effects

MOVIE MARKSMAN

Some of the expert rifle shooting that you see on the silver screen is done by Roy Wade with the compressed-air gun with which he is shown above. Capsule "bullets," filled with dust, spatter when they hit their marks and give a realistic effect without endangering the cast. The gun operates with compressed air at 220 pounds pressure. The tank and connecting hose make the outfit portable.

IN ORDER safely to film the effects of a bullet striking, Roy Wade, chief property man for Republic Pictures studio, has devised a repeating compressed-air gun that shoots capsules instead of bullets. The weapon consists of a smooth-bore barrel about the length of a regular rifle barrel, has gun sights, and is mounted on a specially carved stock. The bore is of .38 caliber, and there is a revolving cylinder at the breech that holds twelve capsules. The cylinder can be twirled by the forefinger to give rapid repeating action—in fact, Wade can shoot it faster than most gunners can operate a bolt-action rifle. A tank of compressed air, equipped with a strap for carrying it over the shoulder, is connected by heavy rubber hose to a steel tube that projects slightly from the rear of the pistol grip on the gun stock.

Using air at 220 pounds pressure, the weapon shoots double-0 (.00) medical capsules loaded with either white or brown fuller's earth. White is used when the capsule is smashed on a dark surface and brown against a white surface. Upon impact, the missile gives off a tiny shower of dust that photographs exactly as if a real bullet had struck the object; but with the new gun cameramen or players are not endangered by ricocheting balls or spattering lead.

The rifle is surprisingly accurate up to 30 or 40 feet. Recently, during the filming of *Spy Smashers*, Wade simulated the effect of a machine gun ripping across a man's chest. As the camera was being turned at slow-motion speed, he shot a straight line of twelve of his trick bullets, the player wearing a thin copper plate under his shirt so as not to feel the sting from the bursting capsules. For another movie he was called upon to produce the effect of a bullet striking between an actor's thumb and forefinger as his hand rested against a tree. Standing behind the camera and about 25 feet from his target, he placed a capsule on the exact spot, the fuller's earth making the hit visible in the picture. Wade's compressed-air gun has been used with safety for all kinds of shots, from firing missiles at rocks so as to rebound to shooting off cowboys' hats.

Dew-Point Recorder for Gas Lines

CONDENSATION and freezing of gas lines extending for miles from fields to centers of distribution can be prevented, so it is claimed, by the use of a dew-point recorder devised by W. R. Beardsley and L. F. Carter of the Colorado Interstate Gas Company. The latter supplies Denver with natural-gas from Texas. The apparatus consists of a small tank filled with an antifreeze solution in which is immersed a gold-plated U-shaped tube and is placed in the system where it enters the Denver metering plant. By means of a by-pass in the main pipe line a continuous flow of gas is maintained through the tube, in both ends of which are plate-glass windows. Above them are a source of light and a photoelectric tube or electric eye, and these are mounted in such a way that the light shining through the U-tube is reflected toward the electric eye. The temperature of the antifreeze is controlled by cooling coils and strip heaters.

The cycle of operations is as follows: When the temperature of the solution in the tank has been cooled by the coils sufficiently to chill the gas and to deposit a film of condensate on the inside surfaces of the highly polished U-tube, the intensity of the reflected light reaching the electric eye is reduced. The latter, which is sensitive to a change of ½ foot-candle, then promptly disconnects the cooling system and brings the heaters into service. When these have warmed the antifreeze to a degree where the condensate disappears, the cooling coils take over again, and so on, continuously. Also immersed in the solution is a bulb thermometer that registers the temperature of the antifreeze on a chart, which likewise records the pressure of the natural gas. From these readings is calculated the dew point. When the latter exceeds the danger point, instructions are at once sent to dehydrating plants to remove more moisture from the gas to prevent freezing.

Log of Our War Economy

"I'll take the job, but don't expect any of them production miracles you read about in the newspapers."

THE following paragraphs contain significant bits of information culled from official press releases sent out by the War Production Board.

APRIL 27—Fancy painting and finishing of metal-working machinery was banned, effective April 30. Only one coat of primer or sealer may be applied, no filler may be used, and not more than two coats of paint, enamel, or lacquer are permitted. Old machine-tool gray is the only color authorized for the final coat. The order is intended to expedite the delivery of machine tools and to convert some of the floor space now used for painting for more productive work.

Effective May 6, the length of hairpins and bobpins was restricted to 2 inches. During the 90-day period starting April 25, manufacturers were limited to one-eighth the metal they used in 1941, which is equivalent to a 50 per cent cut. Only low-carbon steel wire can hereafter be used for making these pins, and the gauge is limited to 0.035 inch, as compared with currently used stock as thick as 0.055 inch.

Donald M. Nelson announced that special consultants drawn from various branches of industry are helping Army, Navy, and Maritime Commission procurement officers determine what types of war work each industry can handle. The consultants are all executives with production and engineering experience.

APRIL 28—Maximum mine prices for bituminous coal were established. They are based on the October 1-15, 1941, prices. Bituminous coal makes up 75 per cent of the fuel requirements of industries and 80 per cent of the fuel burned by railroads.

Motor-fuel prices at filling stations in the seventeen states where rationing is in force were fixed at the highest prices prevailing during March, plus 0.4 cent a gallon for gasoline and 0.2 cent a gallon for diesel fuel. Elsewhere in the country the highest March prices will apply. These maximums became effective May 18.

Gasoline rationing cards for use after May 15 were pictured and described in the press. The rationing will apply to some 10,000,000 car owners.

APRIL 29—To lessen travel, war workers who do not live near their places of employment were urged to move closer, if possible.

APRIL 30—It was announced that, with the signing of the Sixth Supplemental War Appropriation Act of 1942 by President Roosevelt, the total funds made available for the war effort reached $162,000,000,000. Airplanes, engines, and parts account for 23 per cent, and ordnance for 21 per cent.

Donald M. Nelson stated that a system has been evolved for continually reviewing costs and profits on war contracts so that savings effected by mass-production methods will be passed on to the Government. This will obviate the necessity of firms working out detailed figures before taking contracts and will thus speed production.

The setting of maximum retail prices on farming equipment was announced. Last year nearly $1,000,000,000 worth of such equipment was sold, and farmers, with a $13,000,000,000 cash income forecast this year, will have more money to spend. However, as the production of this type of goods will be limited to two-thirds of the 1941 total, it is believed that control is necessary to keep prices from advancing unduly.

L. M. Walling, administrator of the Fair Labor Standards Act, ruled that girls under eighteen years but not under sixteen may be employed in certain industries engaged on Government contracts. The working hours are limited to eight a day between 6 a.m. and 10 p.m.

MAY 1—Curtailment of civilian electrical service in some manufacturing areas was foreshadowed by an order outlining operating requirements for utilities and restrictions for nonessential energy consumers, both of which will be enforced as soon as any shortage of power develops.

MAY 2—To obtain basic financial data for the study of price-control problems the OPA will send reporting forms to 25,000 corporations engaged in manufacturing, mining, construction, and other fields. The concerns will be required to report balance-sheet and income-account data.

Government orders from Czechoslovakia, Free France, Iceland, and Turkey were given the status of "defense orders" and will automatically receive a high priority rating.

MAY 3—To conserve rubber, the WPB issued restrictions on the production and distribution of all types of rubber-tired construction equipment. After June 1, each manufacturer's schedule must be approved by the Director of Industry Operations. This type of equipment used 8,000 tons of rubber tires and tubes last year.

MAY 4—All commercial and governmental users of gasoline in seventeen eastern states were exempted from the gasoline-rationing plan, but were instructed not to use their cars for "luxury or nonessential services."

MAY 5—The use of iron or steel in the manufacture of more than 400 common civilian products was prohibited. The only metals that may be substituted for them

"You fellows know this country can't afford to waste metal, so get that lead out of your britches."

are gold and silver. Included in the list of articles are fountain pens, bathtubs, pie plates, wastebaskets, and cash registers.

MAY 6—Indian kyanite, a refractory mineral used for lining furnaces where extremely high temperatures are used, was placed under allocation.

MAY 7—Machine tools and other metal-working machinery valued at $108,000,000 were shipped during March. This was an increase of 73 per cent over March, 1941.

A further ban was placed on the use of copper and its alloys for civilian products. One of the casualties is the common pin, which can no longer be made of brass.

Because of the scarcity of materials, the use of incendiary bombs for demonstration purposes was prohibited.

MAY 8—Progress was reported on the conversion to war work of the billion-dollar-a-year production facilities of the furniture industry. Many parts of training planes are already being made from wood, thus reducing the demand for aluminum.

Distribution by packers of black and white pepper and other spices that are obtained from the Far East was placed under a quota system.

A manual was issued detailing suggested plans for staggering working, school, and business hours and for promoting group riding in private automobiles.

MAY 9—The death penalty for coat hangers was rescinded. They can still be made, provided their only scarce material is a steel-wire hook.

MAY 11—Maximum prices, based on those prevailing between October 1 and 15, 1941, were established for nonferrous foundry products.

Coal consumers were warned that they must lay in next winter's supply right away if they want to be sure of getting it.

Curtailment of the use of cocoa beans—the source of chocolate—was announced. All are imported, and shipping space allotted to them has been cut 80 per cent. We have a year's normal supply, and curtailment will make it last sixteen months. The United States ordinarily consumes 39 per cent of the world's cocoa beans.

MAY 12—The collapsible tubes we have been turning in when purchasing tooth paste or shaving cream will be shipped to the Tin Salvage Institute of Newark, N.J., which will salvage the tin they contain.

Camelback made entirely of reclaimed rubber is now available for recapping automobile tires, and local tire-rationing boards may permit it to be used by motorists who can show a definite need for driving connected with the war effort. Tires thus recapped are estimated to be good for 5,000 to 10,000 miles of driving.

MAY 14—Limitations of the use of copper for nonessential civilian products such as ash trays and doorknobs have saved 300,000 tons of copper and brass for military uses. Within a few days, 28,000 owners of copper inventories will be notified of a plan under which the Government will buy their inactive stocks of primary and fabricated copper.

Fluorescent lamp makers have been asked to use open-end reflectors and to change their designs in other ways to save steel.

Price reductions on fabricated aluminum products that will save the Government many millions of dollars a year have been agreed to by the Aluminum Company of America.

MAY 15—New installations of air-conditioning equipment, unless for war and essential civilian service, were banned.

MAY 16—Sperm oil, derived from whales and used as a lubricant for breaking in motors, making machine tools, and rifling gun barrels, was placed under complete allocation control. The present difficulties of operating whaling vessels are responsible.

MAY 18—So that boxes, hampers, and crates may be ready for use when harvesting crops, a higher preference rating has been assigned for deliveries of nails and wire to manufacturers of essentially non-metal containers for food products.

Up to May 1, this year's iron-ore shipments on the Great Lakes totaled 8,581,740 gross tons, an increase of 23.9 per cent over the corresponding 1941 period. The 1942 goal is 89,500,000 tons, as compared to a normal annual movement of 50,000,000 tons.

Virtually everything sold by the nation's 1,900,000 retail establishments was placed under price ceilings based on the highest prices during March. Charges by laundries, garages, shoe-repair shops, and like establishments will be put under similar control on July 1.

MAY 19—To inspire workers in the Symington-Gould foundry in New York, a completed tank, built of castings they had turned out, was driven through the plant.

The slogan Q4V is displayed throughout the Cleveland plant of Westinghouse Electric & Manufacturing Company. It means "Quicker for Victory."

MAY 22—To acquaint the country's 1,900,000 retailers with the purpose, meaning, and mechanics of the maximum price regulation that went into effect May 18, more than 1,000 meetings have been held throughout the nation. The next step will be the distribution of 1,700,000 copies of a 44-page booklet entitled, *What Every Retailer Should Know About the General Maximum Price Regulation.*

Declaring that the rubber situation is much worse than most persons realize, four leading war-agency officials called on all motorists to conserve their tires by careful driving and requested all civilians to turn in all scrap rubber in their possession.

The entire output of tantalum, all of which is going into war uses, was placed under allocation control.

To restrict the volume of goods available for sale and thereby help curb inflation, plans are being made to limit inventories of all types of merchandise in the hands of wholesalers and retailers.

MAY 23—The sale of safety razors was prohibited, except to the armed forces which will require 700,000 razors a month for the next two months. The use of copper in razors has been barred, save for plating, and manufacturers are working on a substitute model with a plastic handle and guard and a head of steel or zinc.

MAY 26—J. S. Knowlson said: "There are two ways to end a war: the way France ended it, in slavery and degradation; the way we propose to end it, by turning every effort, every thought, every facility to this end. We are feeling the grip of total war, and things aren't the way they used to be. We are all going through hell, but we are going through—pray God—not staying there."

"The boss tells me we've set a new record for the construction industry. We're behind schedule."

Our Circulation Check

ALL who receive this publication get by mail once every eighteen months or so a questionnaire that they are asked to fill out and return. Each is requested to verify his name, address, and title, to state whether he wishes to continue receiving the magazine, to indicate how many persons read his copy, and to make any desired suggestions to editors and advertisers. If the form is not returned in due time, a second one is sent. The purpose of this regular check is to enable us to keep our circulation list "clean," to eliminate wasteful and costly distribution, and to gain ideas that will enable us to produce a more interesting and helpful magazine. It is a means of "taking the pulse" of our readers, and the results are valuable alike to us and to our advertisers.

The response to these questionnaires has for many years been very gratifying; in fact, the percentage of returns has greatly exceeded the general average obtained by other publications using similar methods. Our most recent check brought 79 per cent of replies: 64 per cent from the first query and 15 per cent additional from the second one. This is somewhat lower than the results of the preceding check, but still a good showing considering the fact that most of our readers are busy people even in normal times, and especially so now. The questionnaires were sent to the 20,346 recipients of the magazine in this country. The names of the 21 per cent who did not answer the two letters were referred to field representatives in the respective territories, and about half of them were retained on our mailing list. In the end, 2,289, or 11 per cent, were cut off, but 1,835 new names were added while the check was in progress, so the net reduction was slight. Twelve per cent of those queried indicated changes in their addresses, titles, or company affiliations.

To those who took the time to make suggestions, or to indicate their liking for the magazine as it stands, we extend thanks. All such notations have been carefully reviewed, and future issues will be influenced by them, insofar as this is possible. "Sour" notes were conspicuous by their almost total absence, and for this we are doubly grateful. The present emergency has imposed restrictions upon our editorial contents and has added to our production burdens, but we will make every effort to maintain our present standard.

Insuring Our Future

FEW persons will deny that fire insurance is a prudent protective measure. If we knew that a vast conflagration was to be visited upon us we would quickly buy additional insurance if it were offered us. Right now, a disaster more horrible than fire, more venomous than poison, threatens our nation. To avert it, we are striving in our various ways as combatants, as industrial workers, as food growers, etc. In addition to our endeavors in these directions we are being asked to help finance the war effort by buying War Savings Bonds. We should need little persuasion to do this, for the bonds are really insurance—insurance that we shall be able to live as we have always lived—insurance of freedom, of self-determination, the right to elect whom we please and to receive adequate pay for what we make or do—insurance that we can do as we wish on our days off and shout "Kill the umpire" if we so choose.

From May, 1941, to April, 1942, bond sales amounted to $4,860,000,000. During the next year the goal is $12,000,000,000. This represents 10 per cent of the estimated national income, or ten cents of every dollar we collectively receive. Systematic buying of bonds is being offered 20,000,000 workers in 50,000 firms through the payroll savings plan. Forty-five per cent of the employees had enrolled up to May 1, and the average monthly investment for each participant was $7.50. To make the plan effective, the number of bond buyers must be doubled, and the average monthly investment increased to $20. Think it over and load up on this national insurance to the limit of your available resources.

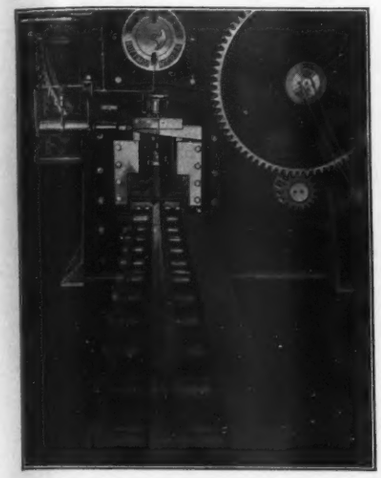
An Ace in the Hole

RESOURCES and research are among America's most potent war weapons. The millions of dollars that American industries have invested in scientific investigations aimed at bettering their products or their production methods are paying big dividends now that shortages of vital materials are developing. Particularly fortunate in this respect is our tremendous automotive industry, now converted almost 100 per cent to war work. Its technologists in peacetime developed many substitutes for regularly used metals. Many of them were better than the standard materials, but were shelved because they were too costly. Now that outlay is less important than producing the matériel that will win the war, full use is being made of them.

By substituting carbon-molybdenum steels for those containing scarce nickel and chromium, certain products are being manufactured with no sacrifice in quality. On a single contract a company thus saved 41,000 pounds of nickel. In making anti-aircraft cannon, laboratory recommendations have so far conserved 420,000 pounds of nickel and 257,000 pounds of chromium in turning out one part alone. In a similar manner, suggested changes in methods of production have wrought wonders. In one instance a total of 3,000,000 pounds of aluminum has been saved, and in another the cost of a certain operation has been cut by $2,000,000. More than 400 of the best engineers in the industry meet regularly and exchange ideas. No company secrets are reserved. Truly, the research work of former years is proving to be an ace in the hole.

Billet Shears for Continuous Operation

FEATURING an air-operated clutch and a patented pneumatic hold-down, the improved Buffalo billet shears are designed for plants where 24-hour service is demanded of them. The hold-down is devised especially for machines equipped for continuous operation with power-feed tables for the cutting of round-cornered square stock or rounds of uniform size and is built into a heavy steel casting that forms an integral part of the shear's main frame. It completely surrounds the knife opening, clamping the bar material securely in advance of the knife movement and releasing it the instant it is sheared through. Both actions are synchronized so that the hold-down functions when the machine is used for occasional or for continuous cutting when the stock is fed automatically with each stroke of the plunger. The bottom of the hold-down bar that comes in contact with the material to be sheared has a hardened tool-steel face.

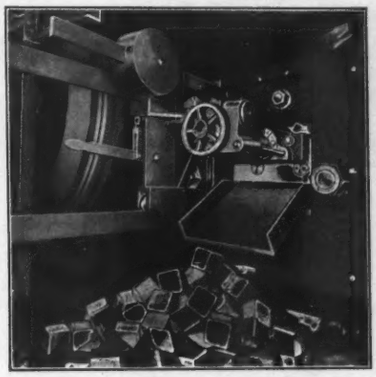


POWER-FEED END

The cutting side of a Buffalo billet shear showing the automatic feed table and the pneumatic hold-down in the engaged position. The latter has a hardened tool-steel face and is placed close to the knives so that the stock is cut with a minimum of waste.

The mechanism of the hold-down proper is operated by an air cylinder that is governed by a remote-control valve and a cam-actuated pilot valve. The clutch is of the jaw type and is engaged and disengaged by a rotating, double-acting air cylinder that is attached to it. The latter arrangement is novel in that the piston remains stationary and the cylinder travels with the clutch. The control valve is operated by depressing a foot pedal, thus simultaneously setting the clamp mechanism in motion and engaging the clutch. From then on the pneumatic controls of the hold-down function automatically in conjunction with the clutch and the main eccentric, to which the cam that actuates the pilot valve is affixed.

To insure smooth and trouble-free service on the part of the air valves and cylinders, including a pivoted unit at the top of the shear frame that counterbalances the movement of the shear plunger, the machine is equipped with a combination water trap and filter that cleans the compressed air, with a sight-feed lubricator that oils the air after it has passed through the separator, and with a pressure-regulating valve and gauge to keep the air throughout the pneumatic system at constant pressure.



DELIVERY END

Rear view of the No. 14 billet shear showing a pile of 4½-inch round-cornered square stock and the chute that feeds it directly into tote boxes or other receptacles.

Rides Both Rails and Roads with Ease

IN THE Auto-Railer, industry has been given a high-speed vehicle that does double duty, for it is said to ride on rails or on the highway with equal facility. It is a development of the Evans Products Company and, because of its dual character, is especially suitable at this time when it is expedient for us to conserve our resources. The vehicles, themselves, are designed to meet varying requirements, and include locomotives for switching service and for hauling loaded freight cars, inspection and maintenance cars, busses, accommodating from 12 to 27 passengers, tractor-drawn trailers and dump bodies, etc. But, regardless of the type, the principle of operation is the same.

Each Auto-Railer runs on pneumatic tires, just like any ordinary motor car. But, in addition, it is provided with steel, flanged wheels that guide it when traveling on tracks and are raised out of the way when it leaves the rails for the road. These pilot wheels are kept under pressure when lowered or are held in the "up" position by hydraulic means or by double-acting pneumatic cylinders using air at from 50 to 100 pounds pressure per square inch, depending on the vehicle. They are not required for locomotion or braking, and carry only a small percentage of the load. The rubber tires for the driving wheels were produced by The B.F. Goodrich Company. They have nonskid treads, and tests have proved that they provide six times more tractive power than do steel wheels. The changeover from road to rail takes less than two minutes, we are informed, and from rail to road less than one minute, and is effected by the driver with the aid of mirrors and without the need of leaving his seat in the cab.

FOR SWITCHING AND BRANCH-LINE SERVICE

This Auto-Railer locomotive is equipped with a 235-hp. gasoline engine and is capable of traveling at a maximum speed of 25 miles an hour. It is a 6-wheel-drive vehicle and has a maximum draw-bar pull of 15,300 pounds. The retractable steel guide wheels are controlled by double-acting pneumatic cylinders supplied with air by a compressor with a capacity of 80 cfm. Air also is used for remote throttle control, and to operate a clutch cylinder, track sanders, and horn.

Industrial Notes

TIME FLIES

As a ceaseless reminder that time is precious, M. M. Gottlieb Associates, Inc., has produced a combination electric clock and poster primarily for industrial use. It's called the Telometer and gives direct reading, ticking off each minute and hour in white numerals 2 inches high. The timepiece has a walnut case 19¼ inches long and 14½ inches high and operates on 110-volt, 60-cycle alternating current.

Leather gasket material in rolls and sheets up to 48 inches wide is a new product of the Armstrong Cork Company for service where acids and alkalies are not encountered and where temperatures do not exceed 300°F.

As a substitute for aluminum paints for nondefense use, the American-Marietta Company has put on the market five new coatings that can be applied by brushing or spraying.

Irritating or sickening odors in painting or finishing departments or around paint jobs generally are preventable, we are informed, by the use of a deodorant made by the Holley Chemical Company. It is claimed that the addition of a very small quantity of the concentrated liquid to varnish, lacquer, enamel, and paint of all kinds will kill the most offensive smell; will not substitute another for it; and will not affect the color, quality, or drying time of the coatings.

In the reduction plant of the Chile Exploration Company at Chuquicamata, the dust bins of the Cottrell precipitator are equipped with regulation air-operated riveting hammers to keep the powdery bulk material flowing freely. Ten such tools are used for the purpose, and each is mounted in a flexible cradle that permits the blows to be directed against the sloping underside of a bin. Compressed air for their operation is taken from the plant's main line and is turned off and on by a remote-control valve.

Under the general heading of *How to Get the Most Service Out of Industrial Rubber Products*, The B.F. Goodrich Company has published six pamphlets that are especially timely. The series covers *Transmission Belting, Conveyor Belts, V-Belt Drives, Belt Salvage, Mats and Matting,* and *Rubber Hose,* and the several subjects are presented in language that any shop or office worker can understand. The company is prepared to send a limited supply of one or more of the pamphlets free to individual firms and suggests that copies be made for general distribution to foremen and maintenance men.

Before long, the gasoline you will be permitted to buy to run your car, if you are lucky enough to have tires, may be odorless. The presence of sulphur compounds, generally known as mercaptans, gives gasoline its characteristic bad smell. The Atlantic Refining Company, according to a recent announcement, has developed a process which removes the offending constituents and therefore the odor from raw gasoline. This, however, is a minor matter from the refiner's standpoint. We are informed that the presence of the mercaptans limits the effectiveness of the tetraethyl-lead treatment, while their removal disposes of that barrier to higher octane ratings. The method, known as the caustic-methanol process, is said to be a comparatively simple one and is available to other refiners by obtaining a license.

To prevent accidents around the home as well as outdoors during blackouts, manufacturers are offering luminous paints and an oilcloth-like material with a phosphorescent coating on one side. The latter is sold in rolls and can be tacked, taped, or cemented to the edges of stair treads, to railings, or to any other guides or obstructions to enable people to move about with safety. Strips of the cloth on the sides, back, and front of automobiles and worn as arm or hatbands or belts will help to prevent collisions between motorists and pedestrians.

Until recently, Switzerland was our main source of supply for jewel bearings, as no synthetic rubies and sapphires or cutting and drilling stones for jewel bearings were produced in the United States. During the first nine months of 1941 our imports amounted to 79,875,751 jewels valued at $1,769,689. With that market virtually closed to us, American industry has stepped in with the result that several companies are now engaged in making synthetic stones while others are converting them, together with natural raw materials, into jewel bearings. The importance of this cannot be overestimated, as they are essential parts of airplanes, time bombs, and a wide range of precision instruments, meters, and other apparatus.

Produc-Trol, an ingenious device that enables the busy executive to keep tabs on his production schedules, has been developed by the Wassell Organization. A true visual aid, it facilitates the checking of raw materials, parts, assemblies, machines, man-hours, etc. Information of this kind is particularly valuable where multiple-shift output is maintained and is listed at the left of the board, as the accompanying illustration shows. In line with each item is a movable tape that works from left to right on pulleys secured to the underside of the board. To the end of each tape is attached a peg, and two rows of peg holes are provided for each tape. These, together with the use of pegs of different colors, give the tabulator wide latitude in arranging comparative and control data for individual jobs. Produc-Trol units can be ordered in sizes to meet specific needs.

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